SCIENCE

23 December 1955

Volume 122, Number 3182

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

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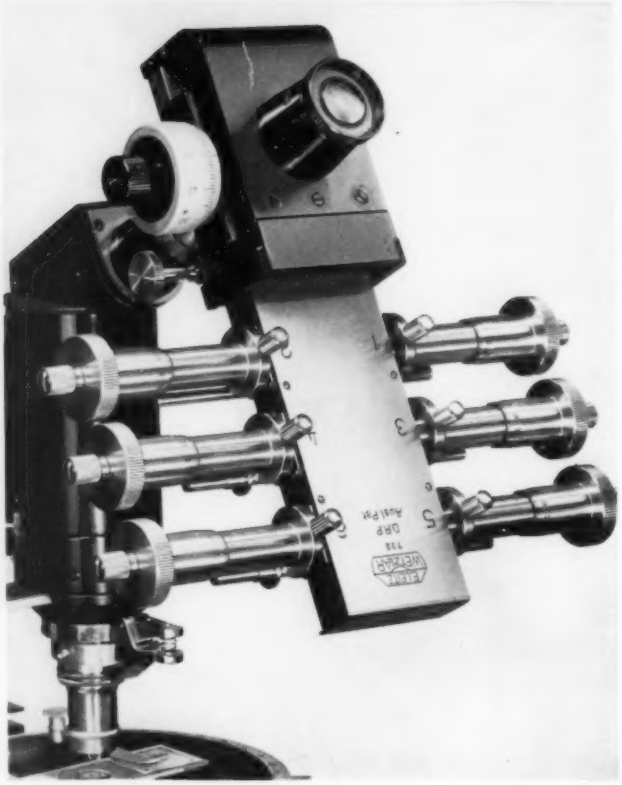

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SCIENCE is published weekly by the AAAS, 1515 Massachusetts Ave., NW, Washington 5, D.C. Entered at the Lancaster, Pa., Post Office as second class matter under the act of 3 March 1879. Annual subscriptions: $7.50; foreign postage, $1; Canadian postage, 50¢.

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SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. Entered at the Lancaster, Pa., Post Office as second class matter under the Act of 3 March 1879.

SCIENCE is indexed in the *Reader's Guide to Periodical Literature* and in the *Industrial Arts Index*.

All correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors.

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The AAAS also publishes THE SCIENTIFIC MONTHLY.

Scientific Manpower Commission

There is a frequent and familiar problem of deciding how general regulations should be applied to a particular group or individual. As a common recent illustration, Selective Service boards and officers responsible for recalling military reservists to active duty have frequently wrestled with the problem of whether or not to require military service of a father, a public official, a student, or a man of particular importance in some civilian capacity. Such decisions must be made on the equities of individual cases, yet guidelines are desirable; thus orders of priority, lists of critical occupations, deferment procedures, and other aids have been developed to assist those who must make these decisions.

Scientists and engineers constitute one of the groups particularly concerned with these matters, for their skills make them critically useful in both military and civilian service, and their numerical shortage makes them hard to replace when military calls take them out of civilian life. Because in many respects these problems can be better handled by an organization that represents all of science than by the individual efforts of individual societies, the AAAS joined with the principal specialized scientific societies a few years ago in organizing the Scientific Manpower Commission. The commission has just held its third annual meeting, and the occasion makes an appropriate opportunity for appraising its effectiveness.

The commission is a good example of cooperation among the sciences and between scientific associations and industry. It consists of representatives of agriculture, biology, chemistry, geology, mathematics, physics, and psychology. It has been supported financially by the sponsoring societies and by generous contributions from industry. Its new president is a biologist; its vice president is a chemist; its secretary is a psychologist; and its executive director, Howard Meyerhoff, is a geologist. The Scientific Manpower Commission has worked closely with the Engineering Manpower Commission. For example, the two organizations jointly publish the *Engineering and Scientific Manpower Newsletter*, an occasional publication that brings to its growing circle of readers current information on legislation, research studies, population trends, and other matters concerning the training and effective utilization of scientific and engineering talent.

The commission has worked on a number of other matters, but most effectively as a consultant to federal agencies that deal with manpower problems. Its advice has been sought in framing legislation, in formulating policy, and in designating occupations in which manpower shortages are of such severity as to recommend that military service be required only when there are specific military requirements for the technical skills of men in those occupations.

That there remains a continuing opportunity for valuable work by the Scientific Manpower Commission can be demonstrated by a single example. In 1955 Congress enacted new military reserve legislation. How the new law will be administered remains to be seen. There will be the necessity for many decisions and there will be opportunity for careful consideration of the ramifications of alternative decisions. The decisions will affect the nation's military strength, educational programs, civilian industry, and scientific progress. In reaching these decisions, the Scientific Manpower Commission will have an important advisory role.—D. W.

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Theory of Elementary Particles

W. Heisenberg

It is obvious that at the present state of our knowledge it would be hopeless to try to find the correct theory of the elementary particles. On the other hand, one may try to form some kind of picture of how such a future theory of elementary particles will look, because, even if we realize that we know only very few details about the elementary particles, we have already quite a good qualitative picture of them, and we feel that even if the experiments go on for 5 or 10 or even more years, this qualitative picture will scarcely change.

Perhaps the best way to start this subject is to give a short review of what we know about the elementary particles, and then the problem of the theory will not be to find the correct theory, but rather it will be to find a model of such a theory. That is, one can, even at the present time, make the attempt to construct theories that at least qualitatively give something very similar to the elementary particles that we see now in nature. Only at a much later stage can we hope to find the correct theory. What I shall try to tell here is in some ways quite ambitious, because it is a model for the real theory of elementary particles—that is, a theory that comprises all knowledge about atomic events, in one single mathematical scheme. On the other hand, it is not so very ambitious, because it is *not* an attempt to find such a theory but only to find a theory that qualitatively resembles it—in other words, a kind of model of such a theory.

Our Knowledge of Elementary Particles

What do we know about the elementary particles? First of all, we know that there is a great number of different elementary particles. We know a mass spectrum of such particles and the masses of many. For instance, the mass of the proton is 1836 times larger than the mass of the electron, so the electron seems to be an especially light particle. Most other particles seem to be heavier by at least a factor of 100. If we consider these masses as something similar to the stationary states in the hydrogen atom, then we see that some of these masses are stable states, and others are unstable states.

The electron apparently is a stable particle and has, therefore, a very sharply defined mass. The proton also seems to be a stable particle, but the neutron is not stable. The neutron can decay, emitting a proton and electron and neutrino. The neutron has a lifetime of roughly a quarter of an hour. Then there are the mesons, which are still much more unstable. Their lifetime is very much shorter. The μ meson has a lifetime of 2×10^{-6} second. The π meson has a lifetime of 2.5×10^{-8} second. The neutral π has a lifetime of only 10^{-15} second. So we see that all different degrees of stability may occur, and as a rule one can assume that when the particles get heavier and heavier, then the chances that they are stable are smaller and smaller, so that probably above a certain mass value all particles will have only an extremely short lifetime. Therefore they will not have a well-defined mass, and then it is of no use to speak about elementary particles.

We know still more about the particles, or, I should say, about the results of any future theory of elementary particles. For instance, we know that any such future theory of elementary particles must contain some invariance properties. It must obey, for instance, all the properties of invariance that are involved in the Lorentz transformation. So they must be invariant for what one calls the inhomogeneous Lorentz group. These invariance properties will lead to a number of conservation laws—conservation of energy, momentum, angular momentum. In connection with quantization, they will also lead to the fact that the angular momentum always is either an integer multiple of $\hbar$ or a half quantum integral of $\hbar$. So all these results must come out of such a theory of elementary particles.

For experiments, these conservation rules mean, for example, that we have selection rules that some particles can only decay into certain other ones. And sometimes we even do not know yet what the selection rules are that apparently are present. For instance, according to all known conservation laws, we think that a proton could disintegrate into a positron and one or several light quanta. But we see that this is not the case; so there must be new conservation laws and, therefore, new invariance properties that have not been accounted for in the present theories.

If we take all this qualitative knowledge together, it seems reasonable to believe that even in 5 or 10 years from now the general picture of this knowledge will probably not have been changed. In 5 or 10 years from now we will certainly know a number of new particles beyond those that we know already. We will have better knowledge of the cross sections and of the production probability of these particles. We will know in what number these particles are created in high-energy collisions, and so forth. But still qualitatively this picture will not have been changed. One important feature of this picture also is that all these particles are connected. By *connected* I mean that when we have a sufficient amount of energy at our disposal—when, for instance, two elementary particles collide at very high energies—then apparently any other type of particle can be created, either directly in the collision or some time after the collision through radioactive decay. So we cannot divide

Dr. Heisenberg is director of the Max Planck Institute of Physics, Gottingen. This article is based on a tape recording of a lecture given before the Indiana Academy at Purdue University, Lafayette, Ind., 15 Oct. 1954.

all existing elementary particles into different groups that have nothing to do with one another. Such a division is in principle certainly not possible. All the elementary particles are connected.

A Wave Equation for Matter

Let us take this qualitative picture of matter, of the behavior of matter, and ask: How can the theory of elementary particles possibly look? We can say: Since we must have in this theory the invariance for the inhomogeneous Lorentz group, it is very natural that such a theory will in some way be connected with a wave function depending on x, y, z, and t. Because, if we write the wave equation for such a wave function, then it is easy to do it in such a way that the invariance for the inhomogeneous Lorentz group actually is present. This wave equation that we want to write, however, will certainly not be a wave equation for a special kind of waves—light waves or meson waves—or a wave equation for nucleons, or anything like that, because the mesons, light quanta, and nucleons must come out of the equation; they cannot be put into it. So this wave equation, if it exists at all, will be an equation for matter, not for any special kind of elementary particles.

What kind of wave function do we have to introduce to represent matter? We may think, just because we have no other mathematical tools, of functions that are scalars, or spinors, or vectors, or tensors—in any case some of these relativistic functions or operators. It would certainly not be convenient or sensible to start by assuming that this wave function of matter is a scalar or a vector, because then this wave equation could never lead to spinor particles. On the other hand, if we assume that this wave function of matter is a spinor, then there is a chance to represent not only the spinor particles but also the scalar and the vector particles, because, if we start with half integers for spin quantum numbers, we can also get spins that are integers by taking several of these half quanta together; but if we start with integral spin numbers, we can never get the half spin quantum numbers. So it looks natural to assume that, if someday we can write a wave equation for matter, this should be a spinor equation.

Then again, one could think of a spinor equation that is just a linear wave equation, like the Dirac equation. This, however, could certainly not represent the facts, because we know that all elementary particles interact. A linear wave equation, however, will never lead to any interaction, and therefore one cannot expect a linear equation to represent the experimental situation for the elementary particles. So we have to start with a nonlinear equation for a spinor wave function, and we shall see whether we can in this way get a model for a theory of the elementary particles.

What is the simplest nonlinear wave equation for a spinor wave? I think I can quickly write it.

$$\gamma_\mu \partial\psi/\partial x_\mu + l^2\psi(\psi^*\psi) = 0 \qquad (1)$$

Here, $\psi^*_{\text{Heisenberg}} = \bar{\psi}_{\text{Schwinger}} = \psi^\dagger\beta = -i\psi^*_{\text{Pauli}}$, where $\psi^\dagger$ is the hermitian conjugate of ψ and β is the Dirac matrix operator for $(1 - v^2/c^2)^{1/2}$. One can argue that other equations are just as simple or perhaps slightly simpler, but essentially this is a very simple equation. As I said before, I do not believe that this is necessarily the correct wave equation. I just want to see whether such a wave equation can lead to a picture of the elementary particles, which at least qualitatively represents what we know about them.

This wave equation has two parts. The first part is just part of the ordinary Dirac wave equation for a spinor function, $\gamma_\mu \partial\psi/\partial x_\mu = 0$. That would be a Dirac equation for neutrinos. Then there is added a term where l represents a constant of the dimension of a length and $l^2\psi(\psi^*\psi)$ is an interaction term. It is the simplest interaction term one can write. It must be a term of the third order, because with a spinor function it would not be possible to have a second-order term with the correct transformation properties. One could imagine other terms of the fifth order and the seventh order, but this seems to be the simplest one. Also, instead of this term of the third order, one could take other terms with some γ operators in them, but this would not essentially change the situation.

I think qualitatively such an equation seems to be a reasonable starting point for a theory of matter. The question is: Is there any chance that the quantization of such an equation will lead to an ensemble of elementary particles, some stable, others unstable, from which one can then calculate other interactions, and so forth? The next question is: Can such an equation be quantized according to the methods that we know for the quantization of wave fields?

The answer to this latter question is: No, because we know now from the theories of Schwinger and Tomonaga, Feynman, and others that in the quantization of fields, one will always run into the so-called "divergency difficulties," and this can be overcome only in some cases by a formalism, which is called the process of renormalization. Not all equations can be renormalized. On the contrary, we can divide all possible interactions into two types: one type can be renormalized and shows what can be called weak interaction; the other type has what we may call strong interaction, and for strong interactions this process of renormalization does not work. This interaction here, however, belongs to the strong-interaction type, and regardless of what kind of nonlinear wave equation we would write for spinor waves, we would always get the strong-interaction type, which cannot be renormalized. Therefore, we have to invent a new scheme of quantization. We have to change the rules of quantization in such a way that on one side we still preserve those features of quantum theory which we know must be true and still avoid the divergence difficulties and get to mathematical schemes that really work.

Commutation Relationships

The next and most difficult problem in connection with such a wave equation is the question: What assumptions can we make about the commutation relationships? So, we will now be interested in a commutator between ψ at one point and ψ or ψ^* at another point. Let me write this commutator.

$$\{\psi_a(x)\,;\,\psi_b{}^*(x')\}_+ = -iS_{ab}(x, x') \qquad (2)$$

This commutator is, in this case, written with a + sign between the two expressions on the left side, because we expect for a spinor wave the anticommutation rules that we know from Fermi statistics. The sum $\psi_a(x)\psi_b{}^*(x') + \psi_b{}^*(x')\psi_a(x)$ is, in the ordinary theory, 0 for any nonvanishing spacelike distances between x and x' and becomes a delta function when the points are close together. This anticommutator (multiplied by i) is usually called the S-function, after Schwinger who made much use of it. The problem is: Can we for this nonlinear theory define a new S-function which in a linear theory would be the Schwinger function?

Let me first state some of its general properties. In the linear theory we know that the anticommutator must be 0 whenever the distance between x and x' is a spacelike distance. This is a necessary condition if we want to preserve the properties of causality that follow from the theory of special relativity. From the theory of special relativity, we learn that all action can be propagated only with a velocity less than or equal to the velocity of light. This means that when two points in a four-dimensional world have a spacelike distance, then no action can go from one point to the other, and vice versa. Therefore, at two such points the wave function must always commute, or in this scheme anticommute, because otherwise it would mean that we would have a deviation from ordinary causality. Therefore, we can form the picture shown in Fig. 1. By "0" we indicate the

regions where the anticommutator shall be 0. It shall be different from 0 in what one calls the future cone and the cone of the past. The dividing lines between this future cone and those parts where the commutator is 0 form the so-called "light cone." These are the points to which a wave can be propagated with the velocity of light.

Such functions as S in the linear theory are called propagation functions, because they really represent only waves that obey the normal wave equation and are propagated as perturbations from a certain point. There is a singular point $x=x'$, $t=t'$, and from this point a wave propagates into the future or into the past. The function that represents the anticommutator is just such a propagation function. This is so in a linear theory. This is quite understandable, because in a linear theory the commutator itself must obey the wave equation. In a nonlinear case, however, this is not true, and we have first to find the connection between the "propagator" on the one side and the commutator on the other side. Now we have to invent some kind of mathematical trick to see the connection between the propagation functions and the commutator. To find this mathematical connection I will have to write a few formulas. Consider the equation

$$\chi_\alpha(x,x') = \exp\{-i[a_\nu\psi_\nu^*(x') + \text{conj}]\}\ \psi_\alpha(x)\ \exp\{i[a_\mu\psi_\mu^*(x') + \text{conj}]\} \quad (3)$$

Right in the middle we find the operator $\psi_\alpha(x)$. Of course, our ψ's are not only functions now, they are also operators, and they shall be noncommuting quantities. And this ψ_α is multiplied on the left side and on the right side with certain factors, which are each other's reciprocal.

The quantities a_ν or a_μ appearing in the exponents shall be the components of an arbitrary spinor with the property of anticommuting with all the wave functions ψ_α. This a_ν is just introduced as a mathematical tool to get the right connection between the propagation functions and the commutator. The factors on both sides of $\psi_\alpha(x)$ depend on x' but not on x. What we have introduced is nothing but a canonical transformation of $\psi_\alpha(x)$ independent of x or α, and

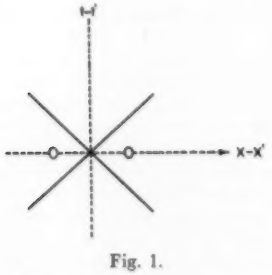

Fig. 1.

therefore one can easily see that the new function $\chi_\alpha(x,x')$ also obeys the wave equation

$$\gamma_\mu\partial\chi/\partial x_\mu + \Gamma\chi(\chi^*\chi) = 0 \quad (1a)$$

Now we can study what the χ will be like. If we assume that this arbitrary spinor a_ν we have introduced is a very small quantity—and since it is arbitrary we can *take* it as very small—then the expansion with respect to a_ν is the following:

$$\chi_\alpha(x,x') = \psi_\alpha(x) - ia_\nu \{\psi_\nu^*(x');\psi_\alpha(x)\}_+ + \ldots \quad (4)$$

The first nonlinear expression appearing in the expansion of χ with respect to a_ν is just the anticommutator. And now we can see the relationship between commutator and propagation function. We see that χ apparently corresponds to a solution of the wave equation, which is not a smooth solution but is a solution where superimposed on a smooth solution there is such a perturbation as we have seen from our picture (Fig. 1)—that is, a perturbation that starts from a point $x=x'$. So the χ is a kind of propagation function. It represents a solution of the wave equation that has a perturbation starting from one point. If we assume that the a_ν is very small, then it is a very small perturbation at the point $x=x'$. And the commutator is then the difference between the original smooth solution and this perturbed solution. So now we know qualitatively at least what the connection between commutator, on the one side, and propagation function, on the other side, must be. The commutator must correspond to the difference between two solutions of the original wave equation, one of which is smooth and the other has this perturbation at the point $x=x'$.

Knowing this we can go further and write our function χ_α, the operator that we have defined, in the following way. We can say

$$\chi_\alpha(x,x') = \chi_\alpha^0(x,x') + c_\alpha(x-x') \quad (5)$$

and this definition is to be understood in the following way. The singularity of the function χ_α on the light cone will be contained completely in the c-number function $c_\alpha(x-x')$ (more correctly, the products of the amplitudes a_ν and a c-number). Such a division is actually possible in any present-day quantum theory, because in present-day quantum theory we always assume that the anticommutator at the origin, at the point $t=t'$, is a c-number. For instance, we usually write the anticommutator as a delta function. Here we assume that we do not know which kind of c-number function $c_\alpha(x-x')$ is, but it is an ordinary function and not a field operator creating or annihilating particles. Therefore we may say that we split the χ_α up into one part χ_α^0 which is an operator, but which is smooth at the light cone, and another part c_α which contains the main singularities and is a c-number.

As I said before, this splitting into two parts has always been possible in present-day quantum theory and will, of course, in a linear theory lead to the ordinary commutation relationships. For instance, we can assume that $c_\alpha(x-x')$ is just the vacuum expectation value of the operator $\pm\chi_\alpha$. Then we can put the χ into the wave equation and, if we have done so, we can take the vacuum expectation value of the wave equation, and we find the wave equation for c. Actually it turns out that this function c is a solution of the original wave equation with only slight modifications. Let me write it:

$$\gamma_\mu\partial c/\partial x_\mu + \Gamma c(c^*c) + c\kappa(s) = 0;\quad s = \Sigma_\mu(x_\mu - x_\mu')^2 \quad (6)$$

For the c the wave equation that one gets is just the same as the ordinary wave equation that is on the left side and is the one from which we started; however, there is one term added, which is the function c times a function of the space-time distance $(x-x')^2$. Since this last term will not affect the behavior of the c near the light cone, and we are interested only in the behavior of c near the light cone, we can just as well assume that this is approximately constant and say c times a certain constant κ, which we can adjust according to what is convenient in the equation.

This gives us a qualitative picture of how the commutator will look near the light cone and how we can derive these properties from a solution of the wave equation. I should mention the following point before I go on. What we need for all further discussion is just the behavior of the commutation relationship near the light cone, because in ordinary theory we already know that we can derive the whole theory if we know only the commutator in the immediate surroundings of the point $x=x'$, $t=t'$. So also here we can be quite satisfied with knowing the commutation relationship very near to this point, because all the rest can be derived by integrating the wave equation. That is, we can then proceed from the time t to time $t+dt$, and so forth, and thereby we can get the whole solution. We are interested only in the behavior near the light cone, and this behavior we can get from solving Eq. 6.

The Solutions

Now I do not want to go into the mathematics of the solution, but I would like to write the solutions in the form of a few pictures. If we solve the same problem for the linear wave equation, then,

of course, we would also find for the function c just a linear wave equation. The term with the third power of c would be left out, and we would get as a solution for the anticommutator the well-known propagation function of Schwinger. Let us for a moment assume that we are not dealing with spinor particles but are dealing with scalar particles, and then we do not have to deal with the S-function of Schwinger but with the Δ-function of Schwinger, which is a function of the distance between x and x' only. This makes it easier to draw pictures, because then we have one single function of only one variable s as in the function shown in Fig. 2.

Vertically we have the Δ-function of Schwinger, and horizontally we plot the space-time distances between the two points. In the case of the linear theory this commutation function of Schwinger, the so-called Schwinger Δ-function, has the following property. It is a Bessel function for all finite distances s, and it is a Dirac δ-function just at the point $s=0$. So at the Δ-axis we have drawn the δ-function as s that would go to infinity, and the oscillating function for positive s is the Bessel function. (Fig. 2.)

This would be the solution of our wave equation for c, if the nonlinear terms were not present. Now we have to study the behavior in the case of the nonlinear theory, where we will first draw a picture for those cases in which the constant a_ν is still finite and not infinitely small. Then, of course, what we get is not the commutator but actually a sum of terms, the first of which is the commutator, and then there are higher terms, which, of course, somewhat change the picture, so that only in the limit for $a_\nu \to 0$ it will become the commutator. The picture will then look like Fig. 3.

For large space-time distances the function again will be nearly a Bessel function, because then the nonlinear terms are very small and do not have strong influence. But for small space-time distances the influence of the nonlinear terms is felt, and then there are some deviations from the old picture. Hence, out at the right we have the Bessel function again, but in the inner part it turns out that there are very fast oscillations so that the function starts oscillating quite rapidly near $s=0$, resulting in an infinitely frequent oscillation with infinite amplitude very near the origin. It is readily apparent that such a function can easily be integrated over the whole distance from $s=0$ to any finite value of s. If we now go to the case where the a_ν is exceedingly small, then this region of very fast oscillation moves always closer and closer to the origin, so finally we are left with a Bessel function for all finite values of s, and only in the origin do we have the fast oscillations (Fig. 4). This means that

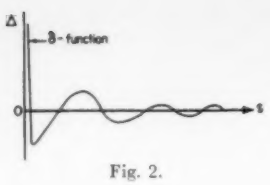

Fig. 2.

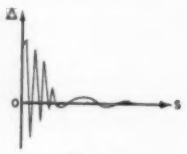

Fig. 3.

now our commutator in the case of the nonlinear theory does almost look like the commutator in the linear theory. The only difference is that the delta function at the origin disappears, and instead of the delta function we have an infinitely fast oscillation; that is, we have an essential singularity, and therefore the value of the function is not defined at this point, but the integral is defined and is always 0 if we only go close enough to the origin. Really *the only difference is the disappearance of the delta function.*

Now this actually helps a lot for the whole divergence problem, because as soon as one starts with the commutation function that has no delta function at the origin, all the divergencies disappear, and we do get a convergent theory.

Before going on, I must write one function that can be derived from the Schwinger propagation function S, which Schwinger calls the S_1-function. This S_1-function is derived from the propagation function S in the following way. One writes a Fourier expansion of the S_1-function, changes the sign of all the Fourier components of which the frequency has a negative sign, and gets a new function, which can be derived from the old one by an integral operation. This function, multiplied by i, is called the S_1-function, and theoreticians know the properties of this function. Here I have a special reason for writing it, and I will just do so in spite of the fact that at this moment it cannot be understood very well why it is useful:

$$S_1(x-x') = i\,[S^{(+)}(x,x') - S^{(-)}(x,x')] = \frac{\kappa^2}{4\pi}\,\gamma_\mu\,\frac{\partial}{\partial x_\mu}\,\mathrm{Im}\left[\frac{H_1^{(1)}(u)}{u} + \frac{2i}{\pi u^2}\right] - \frac{i}{\pi}\,\ln\left|\frac{\gamma u}{2}\right| - \frac{\kappa^2}{4\pi}\,\mathrm{Im}\left[\frac{H_1^{(1)}(u)}{u} + \frac{2i}{\pi u^2}\right]$$

$$\text{with } u = s^{1/2}\kappa; \quad s \lesssim 0 \qquad (7)$$

The point is that this function of u or s has the one property that is important: namely, it contains terms that fall off slowly with distance. The terms in Eq. 7 not containing Hankel functions do *not* appear in Schwinger's work and are added here because of the omission of the Dirac δ-function from our S-function.

The next problem is: If we introduce such commutation relationships, have we any hope that this can lead to a consistent mathematical scheme of quantization? In order to explain why I believe that this can lead to such a scheme, I must go back to some of the mathematical fundaments of present-day quantum theory. I think one can understand these fundaments even if one does not go into the details.

In ordinary quantum theory, the commutation relationships would not be the ones that I put down here. As a matter of fact, in ordinary quantization of wave fields, one does start with rather similar commutation relationships; however, one includes the delta function at the origin, and thereby one gets into all the divergency difficulties. If one omits the delta function, as we are inclined to do here, one ruins the theory completely. That is, one makes in this way a complete change, and the problem is: What price has to be paid for it? Certainly one does not get such a change for nothing. There must be some very serious deviation from ordinary quantum theory. And this I can explain in the following way.

The fundamental difference between quantum theory and classical theory is that in quantum theory not only the actual state of a system is important but at the same time all possible states of a system. For instance, when one is calculating the normal state of a hydrogen atom, it is not sufficient to know that the electron moves in an orbit of radius 10^{-8} centimeter, but it makes a difference whether the hydrogen atom is in a very small volume or in a very big volume. The eigen-states really are different, depending on whether the box in which the hydrogen atom is contained is small or big. That is, the possibility of the atom to get to very great distances is involved in the calculation of the eigenvalue. Or in calculating the scattering of a particle, we usually calculate it with the help of so-called "intermediate virtual" states. These states actually never are occupied, and yet for the scattering it is a problem to know what are the intermediate virtual—that is, possible—states. Therefore, contrary to classical theory, all possible values for a certain quantity are important in the mathematical formulas.

Coming back to the quantization of waves, we say that not only such wave functions as actually do occur in nature are important for quantization of waves but also all "possible" wave functions. From this aspect one comes very easily to an almost absurd conclusion. If, one says, space and time are really continuous in a mathematical sense, then the wave functions of the following type also

belong to the possible wave functions. Assume a wave function that has the value 1 at every point where the coordinates have rational values and has the value 0 at every other point. Such a wave function is pure nonsense from the point of view of the physicist. Still it would be difficult in normal quantum theory to exclude any possible wave function from the mathematical scheme, even if it has some absurd properties, for instance, infinitely fast oscillations. This situation is probably the root of the so-called "divergency difficulties."

How do these divergency difficulties occur in the ordinary mathematical scheme? We usually say that all the stationary states of a quantum theoretical system define a certain Hilbert space. For instance the states of the hydrogen atom can be defined as the vectors in the Hilbert space, and we use it in quantum theory. Here I think it is reasonable to divide the Hilbert space into two parts. We can say that all existing stationary states up to a certain maximum energy, or rather mass, of the total system may be called Hilbert space No. 1. All other states may be called Hilbert space No. 2. The limiting mass may be extremely big. Let us assume the whole mass of the universe. Then it is obvious that only rather smooth functions can be expanded by using the states of Hilbert space No. 1 only, and for the infinitely many other wave functions one would either need Hilbert space No. 2 for expansion or one could not represent them at all. On the other hand, the states of the Hilbert space No. 2 do not occur in nature, and therefore it may be possible to change the rules of quantum theory with respect to these states of the second kind. That is what I do when I omit the δ-function. This change is actually necessary for the following reason: One can calculate the commutator by first going from the vacuum to the first group of excited states and then back to vacuum. Then I go from vacuum to the second group of excited states and back to vacuum, and so on. In any of these cases from every transition I get a function of this type:

$$<\Omega|\psi_\alpha(x)|\Phi><\Phi|\psi_\nu^*(x')|\Omega> + <\Omega|\psi_\nu^*(x')|\Phi><\Phi|\psi_\alpha(x)|\Omega>$$

where Ω is the vacuum and Φ the intermediate state. This is to be summed over Φ for getting the vacuum value of the anticommutator of Eq. 2. Now it has been shown in papers by Gell-Mann and by Low and by Källen and by Lehmann that each group contributes a δ-function at the origin and that all these δ-functions at the origin do not cancel, but they add up. If one says that the δ-functions at the origin cancel, it means that one has given up quantum theory for Hilbert space No. 2. One has sacrificed this

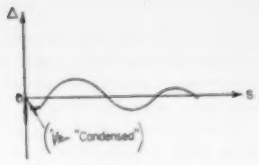

Fig. 4.

and, instead, has got some new mathematical scheme in which one has replaced the total Hilbert space by a thing which one may call a Hilbert space with a roof on top of it. I do not know whether this picture helps the mathematicians, but it shows the purpose of Hilbert space No. 2.

Having introduced this kind of Hilbert space, I am now far away from ordinary quantum theory but perhaps not too far from the experimental situation. So we replace Hilbert space No. 2 by a kind of imaginary Hilbert space, or by what I have called the roof on top of the Hilbert space.

The rest is just straightforward mathematics. So far we have had physical assumptions formulated in a mathematical language—assumptions about the physics of the problem—but from here on we have only mathematics. I shall not go into any calculations but shall just speak about the method and then give the results.

The method that can be used most conveniently is the so-called "new" Tamm-Dancoff method. It is a method that has been developed by Schwinger, Gell-Mann and Low, Freese and Zimmermann of Göttingen, and Goldberger, following an old paper of Tamm and Dancoff in 1941. So it is a rather well-known mathematical frame nowadays, and the great advantage of this frame is that one can work out a mathematical scheme in which one is interested only in matrix elements for those operators or products of operators that lead from the vacuum to a state of a finite energy. That is, one has to do only with matrix elements in Hilbert space No. 1, in which ordinary quantum theory shall be true. The whole contribution from the states of Hilbert space No. 2 comes only in the form of the commutation relationship. So it is quite sufficient for the calculation to know the behavior of the commutator near the point $x = x'$. This we have defined by means of the function given in Eq. 7. So we have actually a mathematical scheme by which we can calculate the energy eigenvalues, and it turns out that no divergency difficulties occur.

Now I will tell the results. One can ask: Are there stationary states; and, are there stationary states, say, with the spin ½, so that the angular momentum is $(\frac{1}{2})\hbar$? The result is that there is a lowest stationary state with spin ½, and the eigenvalue is given by putting κ (the energy or the rest mass of the system) equal to $7.45/l$. That it must have the factor $1/l$ in it is obvious, because l is a constant of the dimension of a length, and if $\hbar$ and c are made equal to 1, which is always done in these calculations, $1/l$ is the same as the dimension of a mass, and therefore this $7.45/l$ is just the eigenvalue of a mass.

We see that this equation leads to one particle, a fermion, which has this mass. If we assume that l is of the order of the Compton wave length of a π meson, which is a sensible assumption for this kind of a theory, then the mass of this particle turns out to be roughly that of the proton. Then one can also ask whether there are particles of Bose statistics, and of integer spin number. One can write the conditions for it, and actually one does get a kind of Bethe-Salpeter equation which leads to the existence of Bose particles. The mass for these Bose particles will again contain the factor $1/l$; and then it will depend on the numerical coefficient of $1/l$ for this Bose particle, whether it is stable or unstable. If the factor would turn out to be of the order of 20, then, of course, it would be unstable, because it could disintegrate into two of these fermions. If, however, the mass turns out to be only, say $1/l$, then it would be a stable particle and could correspond to the π mesons. (*Note added in proof*: Later calculations by Kortel, Mitter, and me have led to the eigenvalues $0.95/l$; $3.32/l$; $0.33/l$ and $1.74/l$ for the masses of Bose particles.) Strangely it turns out in the calculations, as far as we could see (but the calculations are not quite finished yet), that apparently one solution for the rest mass of the Bose particle is just 0. That is, one gets something like light quanta out of this calculation. The reason can be seen as follows. One can start with a different question and then it is easier to judge the answer. What is the interaction between two of the fermions we found? That, of course, follows again from the wave equation. All the interactions are defined by this wave equation. So one has just to calculate what happens when two such fermions are scattered by each other. And it is calculated by normal application of the Tamm-Dancoff method. Then it turns out that between two Fermi particles we have a long-range force of the Coulomb type—a force where the potential energy drops off as $1/r$. This long-range force is connected with the term

$$\frac{\kappa^2}{4\pi}\gamma_\mu\frac{\partial}{\partial x_\mu}\operatorname{Im}\left(-\frac{i}{\pi}\ln\left|\frac{\gamma u}{2}\right|\right)$$

wit $u = s^{1/2}\kappa$

appearing in our new S_1-function as given by Eq. 7. That is, just the very fact that one has omitted the δ-function in the

commutator produces in the S_1-function an additive term that only very slowly decreases as the distance increases. For as I said before, these terms in Eq. 7 added to the Hankel function are the direct consequence of the omission of the δ-function at the origin. The scattering can be calculated in a very rough approximation with the Feynman graph shown in Fig. 5. Say we have two such fermions coming in, then we have to assume interaction through two more such fermions, and finally two come out. If one calculates this Feynman graph, then between these vertex points one has to put in the S_1-function, and therefore one gets an interaction of the Coulomb type. Really this Feynman graph is not a good approximation, so the calculation has to be done more carefully.

So, it seems that this equation has Bose particles of the rest mass 0 as eigenvalues, and this is, of course, a very interesting contribution to the problem of the elementary particles, because it shows that also the light quanta in the real theory of elementary particles may have to do with just this singularity of the S-functions at the origin. If the model of the elementary particles that is formed by the theory is correct, it would mean that the Coulomb forces—the electromagnetic forces—are for nature that method by which nature avoids divergency difficulties, which otherwise are always met in the theory.

Next Steps

The next problem is to calculate the higher boson states and also to calculate for them the corresponding value of $g^2/\hbar c$ and to find whether these quanta are scalar or vector quanta, and so forth. All this is just now in progress, so I cannot report the result. I just want to mention a few problems that are important and should be solved before one can take such a model quite seriously.

One of the most important questions will be: Does there exist some invariance property that corresponds to the gage invariance in electrodynamics? Only if this gage invariance is actually present, does one have a real analogy to the experimental situation. This gage invariance is, of course, decisive for the conservation of charge, the determination of $\frac{e^2}{\hbar c}$, and so forth. It may be that the gage invariance comes out by itself in the theory. This would be extremely interesting, if it were so. It may also be that it restricts the possible assumptions about the main interaction term. This would also be a very interesting result.

The next step would be to calculate the masses of the different Fermi particles and the different Bose particles and see whether that has any resemblance to the actual elementary particles.

This is the general picture of what I wanted to tell. I would like to add a few remarks about the difference between such a scheme and what one has hitherto done in the theory of elementary particles, especially in the quantization of wave fields. Usually in the quantization of wave fields one says: We have free particles, and there is an interaction. We first assume that the interaction is small, and then later we try also to account for strong interactions. Here we see that such an assumption would be complete nonsense. There is absolutely no meaning in saying: Let us first assume that the coupling, the nonlinear term, is small. If we would assume that this constant l, which has the dimension of a length, is small, this would not change anything in the theory at all, because it would just make a similarity transformation in the whole theory. That is, all masses would become bigger proportional to $1/l$, but the spectrum of these masses would not be changed. So it just means that the dimension of the whole world would change, but the eigenvalues and the whole spectrum—all that—would not be changed. Therefore in such a theory the idea of small interaction is just nonsense. Also the idea of free particles that have no interaction in a first approximation is nonsense in such a theory, because the particles are found in exactly the same mathematical frame in which all the interactions are found. That is, in such a theory, not only all the masses of the particles would be determined, but at the same time all the interactions would be determined. Therefore, in such a theory it is quite obvious that one would get a definite value, for instance, for the fine-structure constant $e^2/\hbar c$. Then, one may say: Is there not a danger that one still will come to some contradiction in such a theory, for instance, with respect to the law of causality? May it not be that, on account of introducing this rather strange commutation function, one gets deviations from causality, which then lead to a scheme that we cannot accept from the experiments? On the other hand, we have introduced the commutator from the closest possible analogy with the propagation functions, and the propagation functions, since they are calculated classically, are functions that obey the ordinary rules of causality. Therefore I put it that it seems as least unlikely that one gets into trouble with deviation from the causality, although one must admit that the theory is not yet so well studied that one can be absolutely certain.

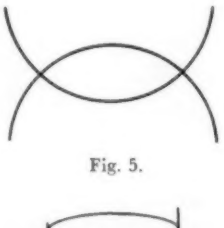

Fig. 5.

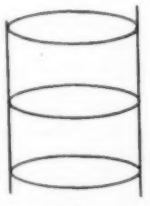

Fig. 6.

There may also be some difficulties with the convergence of the mathematical scheme, but in any case one can say that all those divergency difficulties, which one knows normally from the quantization of waves, do not occur here. Whether other difficulties may occur—say, the question whether the Tamm-Dancoff method converges—is a different matter and remains to be seen.

So, generally speaking, I certainly do not say that this is already a good and sensible model for the theory of the elementary particles, but I would like to say that, whatever one will in the future do for obtaining a theory of elementary particles, one will have to look in a similar direction as here. That is, one will have to look for a theory in which one does not start from the wave equation for the mesons or the nucleons or anything like that, but one will have to start with an equation for matter only, and one will have to try to derive all the different masses of the elementary particles from just one wave equation, of which these masses shall be the eigenvalues. So I think this tendency toward such a theory is almost necessary, but as to the exact form in which one will gradually be induced to give it, one will have to be led by what will come out of it.

Discussion. In what sense can one say that "fermion states" or "bosom states" are found from Eq. 1? Answer: Such states are obtained from the vacuum state Ω by operating on it by an odd or an even number of factors ψ or ψ^+. Maybe a meson interaction between fermions will look, as a Feynman diagram, like a ladder with loops, (Fig. 6). Again let me stress that the limit $l \to 0$ is meaningless; the theory goes over into "ordinary" quantum theory in problems of low energy where one does not consider transitions to virtual states of high energy, because one stays inside Hilbert space No. 1 anyhow.

John E. Potzger, Student of Vegetation

Tremendous vitality and drive were characteristic of John E. Potzger. He chose for his principal research a field of study that demanded hard physical labor, and his work took him into places that were very difficult to reach throughout eastern North America from Texas to Hudson Bay. His work took him into bogs that are the wildest, least frequented kinds of places. He was searching for buried records of past vegetation. He was studying late glacial and postglacial history over this extensive area, using the techniques of pollen analysis. It is true that he also conducted other types of ecological research, but it is this for which he will long be known. There is almost no part of eastern North America where a student of postglacial vegetation can fail to recognize the pioneer work of John Potzger. Although others may have made more intensive local studies, he has covered a broader territory in this work in the United States and Canada than any other one person.

The circumstances of Dr. Potzger's early life undoubtedly conditioned a natural inclination to turn to the wilderness for his research and to pursue it with physical and mental discipline. His father was a Lutheran minister in the "lumber" country of Presque Isle County, Mich. This region was then a wilderness in which pioneers lived in small communities in the generally forested country with very poor roads connecting them. In writing about his early life there, Dr. Potzger has said, "I was born July 21, 1886, and from my earliest recollections I loved the unrestricted life of the wilderness, and much time was spent in the woods. We knew there were wildcats and bears in abundance, but we never 'worried' about them and neither did our parents. We had no high school, no dentist, no doctor or railroad in our county. Mail came by stagecoach from Alpena, and when snow lay deep in winter the outside world had no meaning for us." After 7 years of very rural grade-school training at 4 months a year, Dr. Potzger entered the Lutheran Teachers' College at River Forest, Ill. There he became interested in music. Then for 24 years he taught in a Lutheran Day School in Indianapolis, Ind. He was organist, choir director, and leader of young people. During this time he also devoted much time to the study of music.

This experience ended when he decided to earn an A.B. degree at Butler University. He was 39 years old when he enrolled in the general botany course taught by the late Dr. Friesner. As has so often happened to people with enthusiasm, drive, and ability who came under Dr. Friesner's influence, John Potzger was thenceforth destined to become a botanist. A new life was beginning at age 40. Perhaps this is why Dr. Potzger always seemed young to those of us who knew him well. He entered a new field of work at 40 with the freshness and energy of a young graduate student just out of college. At age 46 he received the Ph.D. degree at the Indiana University; his research was on the forest vegetation of Indiana. But he soon entered the field of postglacial vegetation study, the initiation of his long and extensive work on pollen analysis.

At the time of his death, Dr. Potzger had not even reached "middle age" in this scientific career. He still had a youthful enthusiasm and fascination for his work. Few people who knew him would have guessed within a decade his age. On 6 September 1955, he delivered his address as past president of the Ecological Society of America. When he died less than a month later (18 September), he was well along in his 70th year. He had been on the staff of the department of botany of Butler University for 23 years and had published more than 80 scientific papers during that time. While he will be remembered by his friends for his dynamic personality, he will be known much longer in the scientific world, partly for his contribution to Indiana botany, but much more widely for his extensive work in the postglacial vegetational history of eastern North America.

MURRAY F. BUELL
Department of Botany, Rutgers University, New Brunswick, New Jersey

Science! true daughter of Old Time thou art!
Who alterest all things with thy peering eyes.
Why preyest thou thus upon the poet's heart,
Vulture, whose wings are dull realities?
How should he love thee? or how deem thee wise,
Who wouldst not leave him in his wandering
To seek for treasure in the jewelled skies,
Albeit he soared with an undaunted wing?
Hast thou not dragged Diana from her car?
And driven the Hamadryad from the wood
To seek a shelter in some happier star?
Hast thou not torn the Naiad from her flood,
The Elfin from the green grass, and from me
The summer dream beneath the tamarind tree?

EDGAR ALLAN POE, *Sonnet: To Science*

News of Science

Discovery of the Antiproton

The discovery of the antiproton was announced recently by Ernest O. Lawrence, director of the University of California Radiation Laboratory in Berkeley. The new particles, also called negative protons, were produced and detected with the bevatron, the Atomic Energy Commission's accelerator at Berkeley.

The newly reported work was done by four physicists at the Radiation Laboratory—Owen Chamberlain, Emilio Segrè, Clyde Wiegand, and Thomas Ypsilantis. These four authors acknowledged the important cooperation of E. J. Lofgren, director of the bevatron, and the assistance of Herbert Steiner.

The existence of the antiproton had been suspected for many years by analogy with "antielectrons." Antielectrons were predicted by the Dirac theory of the electron, which was formulated in 1928. The antielectron was later discovered by C. D. Anderson of California Institute of Technology. It is a particle just like the electron, but it has the opposite electric charge. The antielectron is well known to nuclear physicists and is called the "positron." The question was soon raised whether or not the proton was a particle to which the Dirac theory also applied; if so, then antiprotons should be observable.

Until recent years, no accelerator has had sufficient energy to produce antiprotons. For this reason, attempts to see them were restricted to cosmic-ray investigations. In cosmic radiation there are particles of sufficient energy to make antiprotons. Although physicists have long looked for antiprotons in the cosmic rays, no antiprotons have thus far been positively identified.

The California physicists have identified the antiprotons by simultaneously measuring the momentum and velocity of the particles coming from a target in the bevatron. The target, which was made of copper, was struck by the proton beam of the bevatron, each proton having an energy of 6.2 Bev. This is enough energy to cause the production of a pair of particles (one proton and one antiproton), by the reaction proton + neutron + energy → proton + neutron + proton + antiproton.

Using analyzing magnets and magnetic lenses, the physicists extracted from the particles emerging from the bevatron target those that were negatively charged and had momentum 1.2 Bev/c. Pi-mesons of this momentum have an energy of 1060 Mev and a speed very nearly equal the speed of light, while antiprotons of the same momentum would have an energy of 570 Mev and a speed about three-quarters of the speed of light. The research group determined the speed of the particles by observing them in two counters placed 40 feet apart. By measuring the time of flight between these two counters, they determined the speeds of the various particles.

Since the time-of-flight apparatus was not regarded as completely reliable, the investigators confirmed their speed determinations with special Cerenkov counters that were designed to count only particles of a particular speed. This procedure showed that there was among the mesons a small fraction (one in 44,000) of particles with just the right speed for antiprotons.

The outcome of the new work is the discovery of a particle with the same mass (within 5 percent) as the proton, but with negative charge. This particle has been assumed to be the antiproton, the negative counterpart of the ordinary proton.

Theory predicts the properties of an antiproton in quite great detail. The mass must be the same as the proton mass, but the charge must be negative. The spin of the antiproton must be one-half unit, it must obey Fermi statistics, and its magnetic moment must be exactly opposite that of the ordinary proton. In vacuum, the antiproton is stable; it does not decay in any way.

Furthermore, when an antiproton comes in contact with an ordinary proton, it must be possible for an annihilation process to occur in which both the antiproton and the ordinary proton are destroyed. In such a process, the combined rest energy of the two particles will appear in a different form, very probably as a number of pi-mesons.

In the production process for antiprotons, another particle must also be produced at the same time, an ordinary proton. Thus, a pair of nucleons is made at the production process, and a pair of nucleons is destroyed at the death of the antiproton. In these two processes of production and annihilation, there is no net creation or destruction of nuclear matter.

It will presumably be many years before all the expected properties of the antiproton can be measured. Up to the present time, only the charge and mass are well known. While the discoverers of the new particles believe it is correct to assume that these particles are antiprotons, they are aware that the new particles might be some different but previously unknown type of particle. In the coming months, much effort will be put into the important determination of the amount of energy released at the annihilation process, and attempts will be made to observe the annihilation process in cloud chambers, bubble chambers, and photographic emulsions.

The existence of the antiproton virtually guarantees the existence of another particle, the antineutron, because neutrons and protons play very similar roles in high-energy physics. It is believed that antiprotons may become antineutrons in certain types of scattering processes; and vice versa, antineutrons may become antiprotons in scattering processes. Either of these interchange processes may be very useful in finding the antineutrons (which might otherwise be quite difficult to detect).

It seems clear that the discovery of the antiproton has opened a new and entrancing field of basic research. It is hoped that much new information about many of the fundamental particles of matter may be obtained through study of the antiprotons.

Hugo Theorell

Hugo Theorell, who has been awarded the 1955 Nobel prize in medicine, is a Swedish biochemist who is now the head of the biochemistry department of the Nobel Institute in Stockholm. The prize has been awarded to Theorell for his contributions to knowledge of the enzymes that catalyze oxidation-reduction reactions. He has carried out work on many of these enzymes, including yellow enzyme, lactoperoxidase, horse-radish peroxidase, lipoxidase, and cytochrome *c*. Perhaps of greatest importance among his researches was his study of "old" yellow enzyme ("yellow ferment") in 1934.

In 1925 Bleyer and Kallman had separated a yellow material from milk. Szent-Györgyi and his coworkers in 1932

obtained a yellow preparation from heart muscle and observed that the yellow color disappeared on reduction and reappeared on oxidation. In 1932 Warburg and Christian described a "yellow ferment" that they had separated from yeast. They and other investigators during the following few years were able to show that the yellow color was due to a substance of small molecular weight that could be separated from the remaining material. The constitution of this dye, riboflavin, was determined independently by Kuhn and coworkers and by Karrer and coworkers in 1935.

Warburg and Christian had thought that the dye was attached to a carbohydrate molecule with high molecular weight. The problem was attacked by Theorell in 1934. He built an apparatus by means of which the enzyme could be purified by electrophoresis and in this way obtained a homogeneous material, the pure enzyme.

He found that the prosthetic group could be separated from the remaining part of the molecule by dialysis in acid solution. The prosthetic group was found to be the monophosphate of riboflavin, the remainder of the molecule being a specific protein. Theorell was able to recombine the riboflavin phosphate with the specific protein to obtain the complete enzyme with its original enzymic activity. This was the first time that an enzyme had been reversibly separated into its prosthetic group and specific protein.

For many years, Theorell has carried out studies of the heme enzymes, including lactoperoxidase, horse-radish peroxidase, and especially cytochrome *c*. These studies have led to a deep understanding of the structure and mechanism of action of these oxidation-reduction enzymes. At first, the work on cytochrome *c* involved the investigation of physical-chemical properties such as absorption spectra and magnetic susceptibility. In connection with the studies of magnetic properties, he devised and constructed a magnetic apparatus with much greater sensitivity than those previously used.

In recent years, Theorell has carried out the peptic degradation of cytochome *c* and has made a study of the structure of the part of the protein that is connected to the heme group by bonds to the sulfur atoms of two cysteine residues. The study, completed by other investigators, showed that the peptide sequence is valine-glutamine-lysine-cysteine-alanine-glutamine-cysteine-histidine-threonine-valine-glutamic acid, and Theorell and Ehrenburg have proposed a detailed three-dimensional molecular structure for this part of the molecule, including the heme.

Theorell was stricken by poliomyelitis when he was a young man, and he then abandoned his career as a medical practitioner. He now walks with some difficulty, with the aid of canes.

He received the prize of $36,720, a medal, and a diploma on 10 Dec. from King Gustav Adolph of Sweden at a ceremony in Stockholm at which the prizes in chemistry, physics, and literature were also awarded.

LINUS PAULING
Gates and Crellin Laboratories of Chemistry, California Institute of Technology, Pasadena

News Briefs

■ Secretary of the Interior Douglas McKay has announced that his department has dropped the plan for a dam at Echo Park that would flood part of the Dinosaur National Monument from its program for developing the upper Colorado River Basin.

■ At the end of November, 14 leading physicians and surgeons from 13 countries completed a 38-day tour of the United States that was devoted to observations and to an exchange of views with American colleagues on developments in the field of atomic medicine. During the visit, the second such tour made under Government sponsorship, special emphasis was given to the application of new techniques in cancer treatment as well as to the general medical applications of atomic energy.

■ Thomas Alva Edison's laboratory at West Orange, N.J., center of his inventive work for the last 44 years of his life, has been given to the Government. It will become a National Monument. Simultaneously, Secretary of the Interior Douglas McKay designated Glenmont, the late inventor's home in West Orange, as a national historic site under non-Federal ownership. The deed to the Edison laboratory land and buildings, donated by Thomas A. Edison, Inc., was presented to McKay by Charles Edison and Mrs. John Eyre Sloane, son and daughter of the inventor.

■ The Atomic Energy Commission has established a 12-member Advisory Committee of State Officials to consult with the commission on regulations concerning health and safety aspects of private atomic energy activities. The first meeting of the committee will take place within 2 months.

The committee members represent state agencies such as health, labor, public utility, and legal departments. Some are from states already doing work in radiation protection. Among advantages expected from the consultative arrangement, the AEC cited the following:

Close cooperation between the AEC and the states should help in attaining uniformity in regulations. Some states have already issued, or are about to issue, codes and regulations on radiation protection; others are doing preliminary work.

Working through the advisory committee, the commission will keep informed of the needs of the states and will be better able to help states requesting technical guidance.

In general, the arrangement will provide for exchange of information that will be of aid to the commission in discharging its regulatory responsibilities and to the states in keeping themselves informed of the activities of the commission.

■ The first Swedish atomic fuel plant, a new unit near Stockholm, will be in full production toward the end of December. The plant, which is operated by the semipublic Atomic Energy Company, will provide 5 tons of highly refined uranium annually. An experimental reactor for the production of atomic fuel is planned; until it has been completed, the uranium produced will be stored.

■ The Clinic for Reconstructive Plastic Surgery of the Face, perhaps the first of its kind in the United States, is to be established at the Manhattan Eye, Ear and Throat Hospital, New York. John M. Converse of New York University College of Medicine and the Manhattan Eye, Ear and Throat Hospital is surgeon-director of the new clinic, which is being sponsored by the Society for the Rehabilitation of the Facially Disfigured. The clinic will not only treat a patient's physical defect, but it also will provide assistance in personality and vocational problems.

■ Waste heat generated by nuclear reactors is being used for large-scale space heating at the Atomic Energy Commission's Hanford plant, where General Electric Company scientists and engineers are transferring heat obtained from coolant water to air conditioners in various Hanford buildings.

Several buildings are heated by the system. About half goes into a single structure that houses a large reactor that produces plutonium. Equivalent heat would be sufficient to fill the needs of more than 1000 average-sized homes. The new heating system operates as follows:

The coolant water is pumped to a heat exchanger, where it gives up its heat to an ethylene glycol water solu-

tion, which in turn transmits the heat to air conditioning systems in various Hanford buildings. The reactor coolant is held until its radioactivity level has decreased to a point where it can safely be discharged into the river.

■ Two source-of-fact reports on science, *Scientific Personnel Resources* and *Federal Funds for Science,* have been issued by the National Science Foundation under its continuing program of surveying scientific activities in the United States. *Scientific Personnel Resources* is a summary of data on the supply, utilization, and training of scientists and engineers. One section of the report shows, among other things, that there were approximately 200,000 scientists and 650,000 engineers in the United States in 1954; these figures are broken down to indicate distribution by field, age, and level of education. Another section on the education of scientists shows that at a time when the high-school population is rapidly increasing, the number of college graduates completing standard requirements to teach high-school science and mathematics has decreased from a high of 9000 to an estimated 4000 in science, and from a high of 4000 to an estimated 2300 in mathematics between the years 1950 and 1954.

Federal Funds for Science is the fourth report of its kind issued by the foundation designed to provide uniform and accurate data on funds made available by agencies of the Federal Government in support of scientific research and development. Its substance covers fiscal years 1954, 1955, and 1956—the last two estimated. Actual Federal Government expenditures for research and development in fiscal year 1954 were more than $2 billion. This represents approximately a 20-fold increase in Federal expeditures for research and development since 1940. Less than 7 percent of the 1954 total was obligated for basic research—$116,000,000.

Copies of these two publications may be obtained for 50 cents and 30 cents, respectively, from the Superintendent of Documents, Washington 25, D.C.

■ A simple fallout meter to measure the gamma rays resulting from nuclear explosions has been constructed by the Naval Research Laboratory, which has just released a report of this research project. The meter uses a battery, a cadmium sulfide crystal, and a parallel combination of a condenser and neon flash lamp. It uses only commercially available parts, is sensitive over the range of 0.1 to 1000 roentgens per hour, is reasonably energy-independent, and has a flash rate proportional to gamma dose rate.

The report points out that it was felt desirable to construct a simple, small-sized meter that would be inexpensive and that could be distributed widely. *A Simple Meter for Radioactive Fall Out,* Naval Research Laboratory, June 1955, may be obtained from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.; price, 50 cents. Complete with schematic drawings and photographs, the report contains 12 pages.

Scientists in the News

DETLEV W. BRONK, president of the Rockefeller Institute for Medical Research, is the newly elected chairman of the National Science Board, governing body of the National Science Foundation. He succeeds CHESTER I. BARNARD, whose term as chairman has expired.

PAUL M. GROSS, vice president and dean of Duke University, is the new vice chairman of the board and chairman of the executive committee.

MEREDITH R. GARDINER has been named chief of the new division of pathology, Eaton Laboratories, Norwich, N. Y. All toxicological work in the research department, including the histologic examination of animal tissues, will be handled by his division. Gardiner has worked as a veterinary scientist or practitioner since his graduation from the School of Veterinary Medicine, University of Pennsylvania, in 1940. As an animal pathologist, he has been associated with the University of Pennsylvania, the Georgia Coastal Plain Station, the Wyoming State Veterinary Laboratory, and the University of Delaware.

JAMES L. WHITTENBERGER, professor of physiology at the Harvard University School of Public Health, has been named assistant dean of the university's faculty of public health. He will share the administrative responsibilities of the assistant deanship with Hugh R. Leavell, who has served as an assistant dean since July 1954.

New appointments to associate professorships at the University of Mississippi are VIRGIL BENSON, chemistry; GERALD C. TANGER and HUGH B. KERR, mechanical engineering; JOHN DOUGLAS, geology; W. L. BYATT, physics; THOMAS L. SWIHART, physics and astronomy; and JOHN B. MORRIS, psychology.

A. L. COPLEY of New York has been appointed Chargé de Récherches at the Institut National d'Hygiène in Paris, France. He has completed his work on experimental tuberculosis at the Laboratory of Physiology of the International Children's Centre in Paris. His studies, which he has conducted since 1952 at this United Nations affiliate, dealt with the effects of mycobacteria on capillary blood vessels and on platelets.

BRET RATNER of New York recently received the following tribute: "By unanimous vote of the Section on Allergy of the American Academy of Pediatrics, assembled in Chicago at the Twenty-third Annual Meeting of the Academy, this Scroll is awarded . . . as an expression of gratitude and appreciation for his untiring services in advancing Pediatric Allergy, as a pioneer investigator and teacher, as organizer of the Section on Allergy and its first Chairman, for his successful efforts in obtaining recognition by certification for Pediatric Allergists in the Subspecialty of Pediatric Allergy."

WILLIAM A. LADD, specialist in electron microscopy, has become associated with Foster D. Snell, Inc., New York. Ladd was with Columbian Carbon Company for 15 years, where he led work on the use of the electron beam to measure the extremely fine particles of carbon black.

Ladd was a member of the original group at the University of Toronto, headed by E. F. Burton, that pioneered the use of the electron microscope in North America. His most recent achievement has been the development of an x-ray microscope that gives high-resolution micrographs at magnifications of 10,000 to 25,000 diameters.

HOWARD HASTINGS CUMMINGS has retired from the University of Michigan with the title of professor emeritus of postgraduate medical education. He first joined the university in 1906 as a student in the medical school, where he was made an assistant in the department of gynecology and obstetrics in 1910. Cummings has been chairman of the department of postgraduate medicine since 1942.

HERBERT FRIEDMANN, curator of birds for the U.S. National Museum, Washington, D.C., has been awarded the 1955 Leidy medal of the Academy of Natural Sciences, Philadelphia, Pa. The medal is awarded every 3 years for the best publication, exploration, discovery, or research in the natural sciences in such particular branches thereof as may be designated.

Friedmann is being honored for his research in ornithology, his study of the biology of parasitic birds, the monographic works he has published dealing with them, and the discovery of wax digestion by honey guides. His study of these small birds, which lead men and animals to nests of bees, may provide a new means of attacking the tubercle bacillus.

TERRELL L. HILL of the Naval Medical Research Institute, Bethesda, Md., has been awarded a Distinguished Civilian Service award by the Navy. His citation read:

"For exceptional and exemplary accomplishments which have added significantly to the scientific prestige of naval medical research in the field of modern physical biochemistry. You are responsible for advances in statistical mechanics and its application to problems of general chemistry, and for studies of the various properties of molecules found to be responsible for the chemical behavior of cellular machinery. You have investigated the behavior of biological polyelectrolytes and thus greatly aided research on the molecular mechanism of muscle contraction. Your elucidation of the force interactions between dissolved proteins and between them and small charged particles is a matter of wide interest because they underlie a major method of studying the surface structure of proteins upon which so many of our body functions depend."

BARRY G. KING, research executive of the Medical Division, Civil Aeronautics Administration, and associate professor of physiology at Ohio State University, has received the Flight Safety Foundation award of 1955 for distinguished service in achieving safer utilization of aircraft. He was honored for "original contributions to aviation medical and physiological research; for organizing, conducting and evaluating research in the problems of survival and escape from aircraft involved in accidents; for initiative in providing specialist training in the field of aviation medicine."

CHARLES L. MARSHALL, deputy director of the division of classification of the Atomic Energy Commission since 1949, has been named director. CHARLES D. LUKE, director of classification since 1954, has become technical assistant to the director of civilian application for hazard evaluations. Luke will assist in the development of standards, codes, and guides for public health and safety in the design, operation, and location of facilities licensed and operated by the AEC.

JOHN C. REED, staff coordinator of the U.S. Geological Survey, has accepted the chairmanship of the Research Committee of the Arctic Institute of North America. He fills the vacancy created last January by the death of R. C. Wallace. The committee is composed of 13 specialists in various branches of science who are responsible for formulating the institute's research program. Since its founding in 1945, the institute has sponsored 185 field research projects.

GEORGE E. UHLENBECK, Henry Smith Carhart professor of physics at the University of Michigan, has been named Henry Russel lecturer, the university's highest professional recognition of academic and scientific competence. Uhlenbeck, who is internationally known as the codiscoverer in 1925 of electron spin, will deliver the Russel lecture next spring.

HARVEY I. FISHER, formerly of the University of Illinois at Urbana, is now chairman of the department of zoology at Southern Illinois University.

ROBERT W. CAIRNS, assistant director of Hercules Powder Company's research department since 1945, has been appointed director of research. He succeeds EMIL OTT who has resigned to join the Food Machinery and Chemical Corporation.

AKE AKERSTRÖM, Swedish archeologist and head of the Swedish Institute in Athens, Greece, since its inception in 1948, has been invited to conduct research at the Institute for Advanced Study in Princeton, N.J., during the academic year 1957–58.

CHARLES PHILLIPS, who served from 1931 to 1955 as head of the department of surgical pathology and pathological anatomy at the Scott and White Clinic in Temple, Tex., has been named pathologist for the University of Texas M. D. Anderson Hospital and Tumor Institute in the Texas Medical Center, Houston. DALE G. JOHNSTON, former chief of laboratory services of the U.S. Air Force Hospital at Parks Air Force Base in California, has accepted the position of assistant pathologist.

FRANK HERMAN CONNELL, formerly associate director of the Atomic Bomb Casualty Commission in Japan, will serve as chief of laboratory services and as parasitologist at the hospital.

RALPH M. HIXON, dean of the Iowa State College graduate school, has received the Charles F. Spencer award, which is administered by the American Chemical Society's Kansas City Section. Hixon, an authority on the chemistry of starch, is the first recipient of the $500 gold medal award.

The new prize was founded by Kenneth A. Spencer, president of the Spencer Chemical Company of Kansas City, Mo., in memory of his father, CHARLES F. SPENCER, who contributed greatly to the growth of the chemical industry in the Midwest. The award will be given annually to a United States citizen who has made "meritorious contributions to the field of agricultural and food chemistry" in the United States.

DONALD C. RILEY, Office of Statistical Standards, Bureau of the Budget, Washington, D.C., has been named executive director of the American Statistical Association. He replaces Samuel Weiss, who died in July.

CHARLES F. BORN, retired Air Force major general, has joined Texas Instruments Incorporated, Dallas, Tex., as director of service engineering in the apparatus division. The firm manufactures airborne military electronics systems, including radar, sonar, and magnetic airborne detection devices. Born will be responsible for engineering liaison with the many sectors of the Department of Defense and with other defense equipment manufacturers.

JAMES MCCORMACK, JR., retired Air Force major general and former director of research and development in Air Force Headquarters in Washington, D.C., has been named a special adviser to the president of Massachusetts Institute of Technology.

JOSEPH R. MERKEL, formerly at the Institute of Microbiology, Rutgers University, has been appointed director of the Fort Johnson Marine Biological Laboratory of the College of Charleston, S.C. The former quarantine station for the port of Charleston has been acquired by the College of Charleston and is being converted into laboratory and living accommodations. A limited research and teaching program began this fall. When conversion has been completed, considerable space will be available for research and teaching. The major emphasis of the Fort Johnson Marine Biological Laboratory will be on microbiology, but not to the exclusion of other fields of marine biology.

The following men recently received honorary doctoral degrees from Rutgers University: EZRA TAFT BENSON, Secretary of Agriculture; WILLIAM KOMP, medical entomologist at the National Institutes of Health.

D. B. STEINMAN, bridge engineer of New York, N.Y., has received the Marechal Caetano de Faria medal from the Brazilian Government in recognition of his professional achievements and, particularly, in recognition of his engineering contribution to the Republic of Brazil. Between 1924 and 1927 Steinman, with his colleague Robinson, designed and built the Florianopolis Bridge that connects Florianopolis and the mainland of Brazil. This bridge, of a new form invented and developed by Steinman, is still the largest bridge in South America and the longest eyebar suspension span in the world.

ARTHUR KAATZ, U.S. Department of Agriculture entomologist, has left for Tripoli, Libya, where he will join the U.S. Operations Mission of the International Cooperation Administration. Through the mission, he will assist Libyan plant protection officials in programs to control crop and livestock insects, particularly the desert locust. With funds provided by ICA, the U.S. Regional Insect Control Project is helping local government agencies to combat insect pests in Pakistan, Iran, Iraq, Afghanistan, Jordan, India, Egypt, and Ethiopia.

H. GUYFORD STEVER, chief scientist of the U.S. Air Force, has been appointed professor of aeronautical engineering and associate dean of the School of Engineering at Massachusetts Institute of Technology. He has been on leave from M.I.T. since last February to serve with the Air Force in Washington. He will assume his new post in June.

THEODORE I. HEDRICK, formerly a member of the Government's agricultural marketing service, has been appointed associate professor, dairy, at Michigan State University, effective 1 Jan.

SERGE A. KORFF, professor of physics at New York University, has received the Boris Pregel prize of the New York Academy of Sciences. The $500 award is given annually for the best scientific paper on natural radioactive substances. Korff's paper was entitled "Effect of cosmic rays on the terrestrial isotope distribution."

FREDERICK R. FURTH, rear admiral and Chief of Naval Research who has been directing preliminary technical work on the United States earth satellite program, will be retired at his own request at the end of December. He will be succeeded by RAWSON BENNETT, II, a captain and now assistant chief for electronics in the Bureau of Ships.

GLADYS A. REICHARD, professor of anthropology and specialist on Navajo culture who died last July, was honored on 5 Dec. at a memorial meeting at Barnard College. In tribute to Dr. Reichard, two anthropologists delivered papers: Margaret Mead, associate curator at the American Museum of Natural History, spoke on "Commitment to field work," and Frederica de Laguna, professor of anthropology at Bryn Mawr College, had as her title, "Gladys Reichard—appreciation and appraisal." Millicent C. McIntosh, president of Barnard, presided at the meeting, which was attended by more than 100 former students and colleagues of Dr. Reichard.

DUDLEY WILLIAMS, professor of physics at Ohio State University, has received a Guggenheim grant to further his study of the magnetic properties of atomic nuclei. He will sail on 7 Jan. for the Netherlands, where he will spend 3 months at the Zeeman Laboratory of the University of Amsterdam. He will then spend 3 months at Oxford University, England, and 2 months at the University of Zurich, Switzerland.

MARSHALL HALL, JR., professor of mathematics, is another Ohio State Guggenheim fellow. He will spend approximately 2 months at Harvard University and at other eastern universities before leaving for England early in March, where he will conduct research at Trinity College, Cambridge University.

EDWARD CHESTER CREUTZ, professor and head of the department of physics and director of the Nuclear Research Center at Carnegie Institute of Technology since 1949, has been appointed director of research for the General Atomic Division of the General Dynamics Corporation and director of the division's laboratory for pure and applied science. At present he is carrying out a special Atomic Energy Commission assignment on Project Sherwood. He will continue that work until he assumes his new duties full time.

STUART A. RICE of the department of chemistry, Harvard University, and AGNES STROUD of Argonne National Laboratory, have won the two A. Cressy Morrison prizes of the New York Academy of Sciences. Rice's paper was entitled "On the cell model for solutions," and Stroud's paper dealt with the "Effects of continuous irradiation by tritium on cells cultivated *in vitro*." Both of these annual awards are for $300 each.

Necrology

GRACE E. BIRD, Providence, R.I.; 79; professor emeritus of psychology at Rhode Island College of Education; pioneer in the study of child development; staff member of *Psychological Abstracts*; 1 Dec.

WILLIAM B. GREELEY, Suquamish, Wash.; 76; board chairman, American Forest Products Industries; early advocate of forestry research and conservation; former United States chief forester and former secretary and manager of the West Coast Lumberman's Association; 30 Nov.

CHARLES H. HELLIWELL, Dover, N.J.; 58; associate professor of mathematics at the School of Commerce, New York University; 29 Nov.

WILLIAM H. W. KOMP, College Park, Md.; 62; specialist in tropical diseases; medical entomologist in the laboratory of tropical diseases at the National Institutes of Health, Bethesda, Md.; 7 Dec.

WALTER LIBBY, Toronto, Canada; 88; specialist in the history of science; former professor or lecturer at Northwestern University, Carnegie Institute of Technology, the University of Pennsylvania, and the Mellon Institute, Pittsburgh, Pa.; 30 Nov.

KENNETH WILLIAM MAINLAND, Falls Church, Va.; 59; chief of the fats, oils, protein, and seeds branch in the Office of Food and Agriculture, International Cooperation Administration, Washington, D.C.; 5 Dec.

CHARLES MARKHAM, Durham, N.C.; 69; treasurer of and former professor of mathematics at Duke University; 3 Dec.

GLENN MARTIN, Baltimore, Md.; 69; aviation pioneer and founder of the Glenn L. Martin Company, Baltimore; 4 Dec.

JOHN A. NEWLANDS, Hartford, Conn.; president, Henry Souther Engineering Co., Hartford; 2 Dec.

HELEN NOYES, Carthage, Ill.; 73; biochemist; former assistant in orthopedics at the University of Illinois Medical College; 29 Oct.

JAMES F. RINEHART, San Mateo, Calif.; 54; head of the department of pathology at the University of California Medical School, San Francisco; 30 Nov.

HENRY C. STETSON, Belmont, Mass.; 55; submarine geologist and oceanographer at Harvard University; 3 Dec.

ARTHUR L. TATUM, Madison, Wis.; 71; emeritus professor of pharmacology at the University of Wisconsin; 11 Nov.

Education

■ The University of Maryland will formally celebrate the centennial of its College of Agriculture and the sesquicentennial of its College of Medicine beginning on 6 Mar. 1956 and concluding with commencement in June 1957. The Maryland College of Agriculture and the College of Medicine of Maryland formed the nucleus for the present University of Maryland. Ernest Cory, profesor and head of the department of entomology, is chairman of the committee that will guide the 15-month-long celebration.

■ A new college of liberal arts that will emphasize basic science and engineering will be founded at Claremont, Calif., according to William W. Clary, chairman of the Board of Fellows of Claremont college. The new college, which will bear the name of the late Harvey Seeley Mudd, Los Angeles mining engineer and civic leader, is being established as a member of the group known as Associated Colleges in response to an antici-

pated doubling of the college population in Southern California during the next 12 years.

For 30 years prior to his death last April, Mudd was active in the development of the group plan of colleges at Claremont. He served as chairman of the board of Claremont College, central coordinating institution, for 18 years and as a trustee for 29 years. The Mudd family is taking an active part in plans for the development of the new college.

Under the Claremont plan, the new college will share in the use of the central buildings and facilities of the Associated Colleges, including Honnold Library, Bridges Auditorium, the science building, and the medical buildings and services. The present member colleges are Pomona College, Scripps College, Claremont Men's College, and Claremont College.

■ A new Mental Health Research Institute has been established at the University of Michigan within the department of psychiatry, of which Raymond W. Waggoner is chairman. The chief of the institute is James G. Miller, and other senior personnel are Ralph W. Gerard and Anatol Rapoport.

The purpose of the new institute will be centered around the development of a general theory of behavior, with empirical work in both biological and social behavioral sciences. Special attention will be paid to the application of such research to problems of mental health and disease.

■ High-school seniors who are competing for Westinghouse science scholarships in the 15th annual Science Talent Search must mail entries to the Science Clubs of America, 1719 N St. NW, Washington, D.C., *by 27 Dec.* Open to all seniors in secondary schools, the search is conducted by SCA through Science Service. Scholarships are awarded by the Westinghouse Educational Foundation, which is supported by the Westinghouse Electric Corporation.

■ The first section of the first sky atlas [*Science* **122,** 323 (19 Aug. 1955)] has been presented to Amherst College by the National Geographic Society. The gift was made in honor of Gilbert H. Grosvenor, chairman of the board of the society.

On its completion, which will require 8 years, the atlas will contain photographs of all the sky that can be seen from Mount Palomar in California—about 70 percent of the world's total visible sky. The mapping project, on which the society and the Palomar Observatory are cooperating, was begun in 1949.

■ A new graduate program to train laboratory associates in the biological sciences is being sponsored by Hunter College with assistance from the Alfred P. Sloan Foundation. The program is designed to alleviate the acute shortage of personnel in research laboratories.

■ Yale University has announced purchase of a 1-million-volt Van de Graaff particle accelerator. According to Franklin Hutchinson of Yale's newly established biophysics department, the accelerator will be the basis for a study of the use of ionizing radiation to determine the structure and function of cell components.

■ Two detailed courses in specialized phases of documentation will be offered this spring as part of the expanding program of the School of Library Science at Western Reserve University. Classes in "Machine literature searching" and in "Language engineering" have been announced. Course instructors will be James W. Perry and Allen Kent, director and associate director, respectively, of the university's Center for Documentation and Communication Research.

Grants, Fellowships, and Awards

■ Research grants approved by the Tobacco Industry Research Committee in the last year now amount to more than $838,000 with the announcement of 19 new grants and 9 renewals. The committee sponsors research on the use of tobacco; this work is conducted by independent scientists at recognized hospitals, laboratories, and medical schools throughout the country. The committee has set up a $1-million research fund and has pledged more support as the need develops.

Grants are made on recommendation of a nine-member scientific advisory board that directs the committee's research program and policy. Chairman of the board and also scientific director of the committee is Clarence Cook Little, head of the Roscoe B. Jackson Memorial Laboratory at Bar Harbor, Me.

■ The University of Florida College of Medicine, Gainesville, will admit its first class in September 1956. Facilities for graduate study have been provided in the new $5-million Medical Sciences Building, which is to be the first unit in the J. Hillis Miller Health Center.

Graduate teaching assistantships and research fellowships in the basic medical sciences will be available to qualified candidates for advanced degrees. Applications must be received *by 1 Mar. 1956.* Further information may be obtained from the dean.

■ The International Academy of Proctology announces its Annual Cash Prize and Certificate of Merit award contest for 1955–56. The best unpublished contribution on proctology or an allied subject will be awarded $100 and a certificate. Certificates also will be awarded to physicians whose entries are of unusual merit. This competition is open to all physicians in all countries, whether or not they are affiliated with the academy.

The formal award of the first prize and presentation of certificates will be made on 26 Apr. 1956 during the annual dinner dance of the academy at the Drake, Chicago, Ill. All entries are limited to 5000 words; they must be typewritten in English and must be submitted in quintuplicate. Manuscripts must be received *by 1 Feb. 1956.* Entries should be addressed to the International Academy of Proctology, 147–41 Sanford Ave., Flushing, N.Y.

■ The 1956 Freeman fellowship for study or research in hydraulics has been announced by the American Society of Mechanical Engineers. ASME and the American Society of Civil Engineers are joint administrators of the fellowship fund. The Freeman Award Committee makes awards through these societies in alternate years. This year the award could reach $3000, depending on the need claimed in the application.

Any qualified member of one of the two societies who is an American citizen may apply for the fellowship. He must submit a study or research program covering a period of at least 9 months beginning in 1956. Interested persons should submit applications *before 1 Feb. 1956* to the Freeman Award Committee, American Society of Mechanical Engineers, 29 W. 39 St., New York 18.

■ The Engineering Foundation, New York, which administers the income from a $1.5 million fund dedicated to the stimulation of engineering research, has now made available its allocations for the 1955–56 fiscal year. In its announcement, the foundation points out that, although its income of about $50,000 seems very modest in comparison with the present-day scale of research expenditures, it has served to nurture in their early stages many research programs that have ultimately attracted large-scale financial support from other sources and become projects of major import.

This year's grants total $61,850. They will advance 26 projects that are receiving estimated outside support of $426,000. The projects, which cover a wide range of research, are being carried out in university laboratories all over the country under sponsorship of the major engineering societies.

■ The M. D. Anderson Hospital and Tumor Institute has announced a program of cancer fellowships and residencies. Facilities and equipment for therapy and research in the field of malignant diseases are provided for qualified applicants seeking training and research opportunities in oncology. The hospital has 80,000 feet of space devoted to research, clinics equipped to handle 100 new patients and 200 revisits daily, a cobalt-60 irradiator and betatron, and radioactive isotope facilities.

Fellowships and residencies are under the auspices of the University of Texas Postgraduate School of Medicine. Participation in fundamental cancer research, as well as a broad program of education in the Texas Medical Center, is offered. For further information and application forms write to Dr. Grant Taylor, Office of Education, The University of Texas M. D. Anderson Hospital and Tumor Institute, Houston 25.

In the Laboratories

■ Plans to enlarge its facilities for manufacturing glass electronic components in Bradford, Pa., have been announced by the Corning Glass Works. The expansion at Bradford, including the eventual installation of automatic resistor and capacitor production equipment, is part of the company's plan to manufacture and sell components to all parts of the electronics industry.

■ The organization of Bjorksten Research Laboratories for Industry, Inc. to perform industrial and other types of nongovernment research has been announced by Johan Bjorksten, president of Bjorksten Research Laboratories, Inc. Both companies are located in Madison, Wis., with branch offices in New York; Chicago; Washington, D.C.; Dayton and Cleveland, Ohio; and Houston, Tex.

In order to concentrate fully on the development of military research, Bjorksten Research Laboratories, Inc., will function as a special laboratory exclusively for the performance of contracts for branches of the Armed Forces and various Government agencies.

■ General Electric Research Laboratory, Schenectady, N.Y., has established a European office and appointed George J. Szasz as the laboratory's first scientific representative abroad. The purpose of the new office is to strengthen scientific contacts between the G.E. laboratory and basic research activities being conducted in Europe.

As a major part of his activities, Szasz will travel throughout Western Europe, attending scientific meetings and visiting laboratories that conduct fundamental research in scientific areas of interest to General Electric.

From 1948 until his recent resignation to accept the new post, Szasz was with the London branch of the U.S. Office of Naval Research; for the past year he has served as the branch's deputy scientific director. For the present, Szasz will maintain an office with the International General Electric, Ltd., Crown House, Aldwych, London, W.C.2.

■ The Raytheon Manufacturing Company held open house on 3 Dec. at its newly completed electronics laboratory in Wayland, Mass. The $2.5-million, two-story brick structure is situated on a 73-acre site. It has a total floor space of approximately 225,000 square feet, including more than 5 acres of laboratories, offices, drafting rooms, and machine shops. Approximately 1200 employees are housed in the new building. Engineering activities that were formerly carried out in seven separate localities have been consolidated in the Wayland building; most of the vacated floor space in the older buildings has been reassigned to the manufacturing and warehousing operations of the firm.

Miscellaneous

■ Edward Teller tells the story of the atom in a series of three programs released 18 Dec. by the Educational Television and Radio Center, Ann Arbor, Mich. The series is being telecast over the nation's network of educational television stations.

■ Supplementary printed material for the 26-minute sound film *Seifriz on Protoplasm* has been released, and is available free from the Educational Film Library Association, 345 E. 46 St., New York. The film, which was made by the late William Seifriz, professor of botany at the University of Pennsylvania, has won many awards, including a first prize at the Cleveland Film Festival and the highest honor of the Edinburgh Film Festival.

The study guide, which is useful even without the film, consists of an introduction to the study of protoplasm, an amplified summary of the film, and bibliographic references. The reel is for sale at $90 from EFLA, to which rental inquiries may also be directed.

■ A full-scale model of a projected earth satellite will be put on exhibition on 20 Dec. at the American Museum-Hayden Planetarium, New York. The model, 18 inches in diameter, was designed and built by *Popular Science Monthly* after consultation with scientists working on the program to launch an artificial earth satellite during the International Geophysical Year. An identical model is being presented to the U.S. National Committee for the IGY. The exhibit at the Planetarium will be supplemented by panels describing the operation and uses of the proposed satellite.

■ A competitive examination for appointment of Veterinary Officers to the regular corps of the U.S. Public Health Service will be held in various places throughout the country on *28 and 29 Feb. and on 1 Mar.* These examinations provide opportunities for career service in the field of veterinary medicine, research, and public health. Appointments will be made in the ranks of assistant and senior assistant, equivalent to Navy ranks of lieutenant (jg) and lieutenant.

Entrance pay for an assistant veterinarian with dependents is $6017 per year; for senior assistant veterinarian with dependents, $6918. Qualified officers are promoted at regular intervals.

Requirements for both ranks are U.S. citizenship, age of at least 21 years, and graduation from a recognized school of veterinary medicine. For the rank of assistant veterinarian, at least 7 years of college and professional training and appropriate experience are needed. For senior assistant veterinarian, an additional 3 years, for a total of at least 10 years of college and professional training and appropriate experience, are required.

Application forms may be obtained from the Chief, Division of Personnel, Public Health Service, Department of Health, Education, and Welfare, Washington 25, D.C. Completed application forms must be received in the Division of Personnel *no later than 3 Feb. 1956.*

■ The American Industrial Hygiene Association has announced the publication of a series of information bulletins, called *Hygienic Guides*, that will be made available to industry and other interested persons. The purpose of the *Guides* is to provide authoritative information on the toxicity of common industrial materials and to bring together all the pertinent information required for hazard evaluation.

Guides will be prepared on all the common industrial chemicals and materials and each one will include information on the following: maximum allowable concentration for both short- and long-term exposures; significant chemical and physical properties; major uses; evaluation of exposures; engineering control procedures; medical control procedures; and references to literature.

Hygienic Guides sheets may be obtained for 25 cents each from the American Industrial Hygiene Association, 14125 Prevost, Detroit 27, Mich.

Reports and Letters

Mass Screening for Disease-Resistant Mutants in Oats

The development of methods for screening large populations of microorganisms for a few spontaneous or induced mutants has led to attempts to obtain useful mutations from higher plants by similar means. Success in such attempts can be expected only if very large numbers, millions or billions, of individuals can be handled in a reasonable length of time. This requires a screening agent that will eliminate from the population all but a few desired mutant types. In screening for disease resistance, it is also desirable that the selection pressure exerted by the screening agent be adjustable to allow selection of moderately resistant, as well as highly resistant or immune, individuals.

In the work reported here (*1*), a toxin produced by cultures of the fungus *Helminthosporium victoriae* Meehan and Murphy was used to screen oats for mutants resistant to the disease caused by this fungus. The disease, known as *Helminthosporium* blight, has caused severe damage to oat varieties possessing the "Victoria type" of resistance to crown rust and has been responsible for the replacement of these varieties with varieties resistant to *H. victoriae* (*2*). This has not provided an entirely satisfactory solution to the problem, because the latter are more susceptible to certain races of crown rust than are the Victoria derivatives that they replaced. Attempts to combine the Victoria type of resistance to crown rust with resistance to *H. victoriae* by conventional breeding methods have indicated that the two characters may be completely linked (*2*). It therefore appeared worth while to attempt to combine the two characters by screening oat varieties susceptible to *H. victoriae* for resistant mutants.

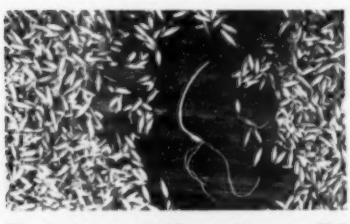

Fig. 1. An oat seedling resistant to *Helminthosporium* blight obtained by screening a susceptible population with a toxic agent produced by the pathogen, *H. victoriae*.

The toxin produced by *H. victoriae* and used as a screening agent in this study has been shown to cause the same disease symptoms and to possess the same host specificity as the pathogen itself (*2*, *3*). This toxin is more than 100,000 times more toxic to oat varieties that are susceptible to *Helminthosporium* blight than it is to varieties resistant to this disease (*3*). Details of methods for the production and bioassay of this toxin are given in another report (*3*).

Certified seed oats of two varieties, Victorgrain 48-93 and Fulgrain, both of which are susceptible to *Helminthosporium* blight, were screened in 12-bu lots. In the screening process, the oats were soaked for 30 minutes in tap water and then spread out in ordinary wooden flats to a depth of about ½ inch. The flats (approximately 200 were required for each 12-bu lot of oats) were then placed in a large stack and the latter covered with burlap, which was kept moist by spraying several times each day with water. After 2 days at a temperature of 27°C the stack was opened, and the oats in each flat were drenched with a solution containing 10 units/ml of *H. victoriae* toxin (*3*). By this time the oats had germinated and developed roots 5 to 10 mm in length. After treatment with the toxin, the flats were restacked, maintained at 27°C for 2 more days, and then removed and examined for the presence of seedlings that had survived the treatment.

The survivors, which numbered approximately 50 per bushel, were separated into two categories; those completely unaffected by the toxin (see Fig. 1) were classified "resistant," whereas those showing some degree of injury or stunting were classified as "doubtful." All the surviving seedlings were heavily inoculated with spores and mycelium of *H. victoriae* and were planted in pots of soil. Counts made 30 days later showed that 92 percent of the plants in the resistant category were alive, whereas only 8 percent of those classified as doubtful survived inoculation with the pathogen.

A total of 100 bu (approximately 45 million grains) of oats was screened; from these, 973 seedlings were obtained that survived both treatment with the toxin and inoculation with *H. victoriae*. These seedlings were transferred to a rust nursery, inoculated with race 45 of the crown rust organism, and exposed to natural infection by other races of rust prevalent in the Baton Rouge area. Nearly half (471) of the plants were highly susceptible to rust and these were discarded. Seed from the remaining plants, which gave rust reactions ranging from moderately susceptible to highly resistant, were retained for further testing.

The entire experiment, including production of the toxin, screening, transplanting, and testing for rust reaction, required a total of slightly more than 800 man-hours. Since no expensive facilities or equipment are needed, it is apparent that tremendous numbers of individuals can be processed quickly and inexpensively by this method. The process, therefore, provides not only a promising means for obtaining disease-resistant plants but also a tool that should be useful in quantitative studies of spontaneous or induced mutation at specific loci in oats.

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29 July 1955

Salt Effect on I^{131} Metabolism in the Salamander

Other than metamorphosis, the role of the thyroid gland in the physiology of the adult amphibian is relatively obscure. Little evidence exists suggesting that osmotic changes in the swimming media may influence the thyroidal uptake of radioiodine by the fresh water amphibian. This report summarizes a preliminary study that was designed to explore the influence of sodium chloride changes in the swimming media on the amphibian metabolism of iodine (*1*).

Adult salamanders (*Triturus viridescens*) of a mean weight of approximately 3.0 g were used. All animals were obtained from a breeding pond in north-

Table 1. Twenty-four-hour distribution of I^{131} in *Triturus* exposed to different salinities of swimming media for 5 days. All groups composed of 20 animals; all figures are percentages.

NaCl added	Activity* retained in whole body 24 hr	Activity† per 100 mg of tail	Activity in total liver	Non-thyroid‡ activity in jaw	Thyroid§ activity in jaw	Thyroid‖ activity in jaw per gram of body wt.
0	80.9	0.94	0.09	1.09	5.40	1.81
0.2	77.9	1.52	0.06	2.44	4.82	1.63
0.4	72.2	1.59	0.25	2.63	4.66	1.62
0.6	66.8	2.06	0.33	3.25	4.36	1.34
0.8	55.1	2.29	0.53	5.19	1.99	0.59

* Whole body I^{131} activity 24 hours following I^{131} administration (less decay) times 100, divided by whole body I^{131} activity (zero time) immediately after I^{131} administration.
† Assayed I^{131} activity in tail portion expressed per 100 mg of tail tissue.
‡ Calculated I^{131} activity of total weight of jaw expressed as I^{131} activity of an equal weight of tail tissue.
§ Assayed I^{131} activity of total jaw less nonthyroid activity in jaw.
‖ Thyroid activity in jaw divided by grams of total body weight.

Table 2. Influence of prior conditioning on the response of *Triturus* to different salinities of swimming media. All groups composed of 20 animals; all figures are percentages.

NaCl added	Activity* retained in whole body 24 hr	Activity† per 100 mg of tail	Activity in total liver	Non-thyroid‡ activity in jaw	Thyroid§ activity in jaw	Thyroid‖ activity in jaw per gram of body wt.
0	82.0	2.00	0.13	2.96	5.21	1.48
0.8	66.2	4.20	0.61	6.70	1.08	0.57

* Whole body I^{131} activity 24 hours following I^{131} administration (less decay) times 100, divided by whole body I^{131} activity (zero time) immediately after I^{131} administration.
† Assayed I^{131} activity in tail portion expressed per 100 mg of tail tissue.
‡ Calculated I^{131} activity of total weight of jaw expressed as I^{131} activity of an equal weight of tail tissue.
§ Assayed I^{131} activity of total jaw less nonthyroid activity in jaw.
‖ Thyroid activity in jaw divided by grams of total body weight.

western Pennsylvania and were maintained prior to use under identical conditions in fresh lake water. All animals were collected within a 2-week period and were used no later than 2 weeks after collection.

Procedures were similar for all groups. Before adjustment of the salinity of the swimming media, all animals were conditioned to filtered, demineralized lake water for 24 hours (less than 5 ppm as NaCl). Individual animals were then placed in adjusted solutions for periods of time as described in a subsequent paragraph. Twenty-four hours prior to sacrifice all animals were injected intraperitoneally with approximately 10 μc of I^{131} in 0.1 ml of 0.7-percent saline. Immediately after injection, each animal was rinsed in distilled water and assayed for total I^{131} (whole body content) by scintillation counting; this procedure was repeated 24 hours later just prior to sacrifice. After correction for radioactive decay, differences between whole body assays of I^{131} were attributed to excretory loss.

Table 3. Response of *Triturus* to 0.8-percent sodium chloride swimming media for different lengths of time. All groups composed of 20 animals.

Time in 0.8% saline (day)	Thyroid* activity in jaw per gram of body wt. (%)	Activity† retained in whole body (%)
1	0.41	71.1
3	0.52	66.2
5	0.59	55.1

* Assayed I^{131} activity of total jaw less nonthyroid activity in jaw.
† Thyroid activity in jaw divided by grams of total body weight.

At sacrifice, each animal was anesthetized with ether and weighed; the lower jaw, total liver, and a portion of the tail were weighed on a torsion balance and assayed for I^{131} by scintillation counting. The excess of the I^{131} jaw activity over the tail aliquot activity per unit weight was attributed to I^{131} accumulation in the thyroid. This activity was expressed as a percentage of the total activity administered.

1) Groups of 20 salamanders were maintained individually in 100 ml of demineralized lake water containing added NaCl (0, 0.2, 0.4, 0.6, or 0.8 percent) for 5 days prior to sacrifice (Table 1).

2) To determine the prior conditioning effect of added salt, two additional groups of 20 salamanders were maintained for a 3-day interval in 0-percent saline and 0.8-percent saline, after which the swimming media were reversed: those in 0 percent saline were placed in 0.8-percent saline, and those previously in 0.8-percent saline were transferred to 0-percent saline solutions. These animals were sacrificed 3 days after the change in their swimming media by the procedure we have outlined (Table 2).

3) Three other groups of 20 animals were sacrificed after 1-, 3-, and 5-day exposures to 0.8-percent NaCl added to the lake-water swimming media (Table 3).

On the basis of the data presented here, it appeared that whole body retention of radioiodine decreased with increased salinity of the swimming media. In addition, I^{131} activity measured in the thyroid in lower jaw by the methods described also decreased with increased salinity of the swimming media and paralleled the decreased retention of I^{131} in the whole animal. Iodine-131 levels of liver and tail tissue increased with increased salinity.

Prior exposure to different saline media did not prevent this response (Table 2). However, animals exposed to 0.8-percent saline swimming media for 1 to 5 days exhibited progressively decreasing amounts of I^{131} retained in the whole body, while the I^{131} thyroid activity tended to recover somewhat during this time (Table 3).

It was concluded that osmotic changes in the swimming media are capable of altering the metabolism of I^{131} in the adult amphibian *Triturus*. Such changes, ecologically, may play a role in seasonal variations of amphibian species.

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Note

1. We wish to acknowledge the use of the facilities of the Pymatuning Biological Field Laboratory of the department of biological sciences of the University of Pittsburgh. Portions of this report were presented at the meeting of the American Physiological Society in Madison, Wis., September 1954.

25 July 1955

Source and Origin of Magnetite at Scott Mine, Sterling Lake, New York

In many metamorphic regions of the eastern United States the rocks contain local concentrations of magnetite. These magnetite bodies are today commonly considered to have been formed by solutions from magmatic sources. The associated host rocks are interpreted to be intrusive igneous bodies, and the ores are believed to be genetically related to these

bodies. If, however, the "igneous" rocks are actually metasomatic, then the current theory of the origin of these deposits is no longer valid.

A number of writers have discussed the magnetite deposits of the eastern United States, in particular Bayley, Miller, Colony, and Alling, and more recently Buddington, Leonard, Postel, Hotz, and Sims. The following discussion is restricted to the Scott Mine, but the concepts developed may have application to other mines (*1*).

The Scott Mine is in a region of metamorphic rocks where quartz-oligoclase gneiss, quartz-monzonite gneiss, and pegmatite have replaced pyroxene amphibolite. Evidence of metasomatism includes the following. (i) Foliation in the gneiss passes uninterruptedly into amphibolite inclusions. (ii) Amphibolite inclusions often contain microcline and other minerals of the gneisses or pegmatite. (iii) Thin section analyses of the quartz-monzonite gneiss made by Offield (*2*) show a considerable variation in mineral percentages along the strike. This is more characteristic of different degrees of replacement of amphibolite than it is of intrusive magmatic rock. (iv) Undisturbed long thin layers of amphibolite are present in the gneiss. (v) Evidence of squeezing or displacement to accommodate intrusion of magmatic material is absent. (vi) No *boudinage* structure around amphibolite inclusions was found that would indicate regional plastic deformation rather than metasomatism. (vii) Foliation and lineation of the gneisses have been inherited from the amphibolite; there is no evidence that these gneisses are metamorphosed igneous rocks. (viii) Microtextures are present that are commonly ascribed to replacement processes. Following the metasomatism, magnetite partly replaced the amphibolite layers in a 250-foot-thick ore-bearing zone.

Microscopic studies suggest that the ferromagnesian minerals within the ore-bearing zone were formerly richer in iron than they are now. The refractive indices of biotite, hornblende, augite, and orthopyroxene in the amphibolite decrease with nearness to the ore-bearing layers. This relationship suggests a decrease in iron content of these minerals. Specimens from diamond drill cores through relatively thick ore bodies show, in general, greater decreases in index than do specimens from core with smaller and fewer magnetite concentrations. The indices of orthopyroxene correspond to a composition of from 57 to 100 molecular percent enstatite. A lowering of refractive indices in most mafic minerals is commonly related to a decrease in iron content; however, other elements may be involved. In the Scott Mine the amounts of ferric iron and titanium may be especially significant, but they have not yet been determined.

The relative amounts of each mafic mineral differ somewhat from place to place in the cores. In most specimens, all four ferromagnesian silicates exist together. Therefore, the systematic decrease in indices toward the ore-bearing zones apparently does not reflect a decrease in iron content of one ferromagnesian mineral because of the presence of other mafic minerals, as Nockolds (*3*) found in a study of biotites.

Loss of iron from the ferromagnesian silicates is believed to have been sufficient to supply that necessary for the magnetite bodies. Since chemical analyses have not yet been made, it is not possible to estimate the amount of iron removed from the minerals. However, the ore-bearing zone in which the refractive indices are lowered is sufficiently extensive to warrant this tentative conclusion. From his study at Lyon Mountain in the Adirondacks, Miller (*4*) came to the conclusion that the magnetite was formed in part by a change of hornblende and hypersthene to diallage of lower iron content and in part by solution of magnetite from the country rock. He felt that this was accomplished by late stage intrusive pegmatites. Miller did not substantiate his ideas by sufficient petrographic and chemical data, but the results we have obtained at the Scott Mine suggest that some of Miller's conclusions may have been justified.

Ramberg (*5*) has shown that iron and magnesium ions substitute in different proportions in different types of silicate structures. This may be the result of the fact that the electronegativity of iron is somewhat greater than that of magnesium. Ramberg has further shown that the electronegativity of oxygen in a silicate is less than that of oxygen in an oxide, and accordingly iron will be preferentially taken up in the oxide (magnetite, in this case) and magnesium in the silicate.

If this process took place at the Scott Mine, the iron in the mafic minerals was expelled and became fixed as replacement magnetite. Such a process, controlled by structural features, is believed to have formed the concentrations of magnetite. During metamorphism and metasomatism, differential movement along planar and linear structures produced high and low pressure zones, and iron migrated to the low pressure zones. Plagioclase is the principal mineral that is replaced by magnetite, and each marked increase in magnetite percentage is accompanied by a comparable decrease in plagioclase percentage. The ore bodies are thought to be a phase of the metamorphism and metasomatism of the region.

Other magnetite deposits in metamorphic regions in the eastern United States and elsewhere may have had a similar origin.

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21 July 1955

"Swimming" Anemone from Puget Sound

Extensive dredging operations have been carried out in recent years by the department of oceanography of the University of Washington in a study of the distribution and assemblage patterns of plants and animals in Puget Sound. While dredging was being carried out in an area north of Seattle, collections were made of several specimens of an anemone identified by Cadet Hand of the University of California as *Stomphia coccinea* (*1*). These animals were placed in aquariums that are provided with a constant flow of filtered sea water maintained at a temperature of 10°C, the approximate mean surface water temperature in Puget Sound.

By accident it was discovered that the attached anemones would free themselves and exhibit a spasmodic "swimming" motion in response to immediate contact with certain starfish. Preliminary experimentation showed that the swimming response occurred when one of the following starfish—*Crossaster papposus, Hippasteria spinosa,* or *Dermasterias* sp.—was placed in contact with the anemone, whereas no swimming response occurred when one of the asteroids *Solaster* sp., *Mediaster aequalis, Henricia leviuscula, Pisaster* sp., *Evasterias* sp. or any ophiuroid, was used.

Further investigation showed that the spasmodic swimming response could be produced by placing electrodes one on each side of the column and stimulating the animal with alternating current at 15 to 25 v and 7.5 amp. Sea water containing the mucoid slime of *Dermasterias* sp. also elicited the same response. However, parts of other asteroids gave no positive results—for example, direct contact with the amputated arm of *Crossaster* elicited no response. The swimming action has been photographed on 16-mm Kodachrome film (*2*). Figure 1 is a schematic

representation of the pertinent activities involved in the swimming response; Fig. 2 is a series of single frames from the film. Briefly described, the swimming procedure is as follows.

1) When the starfish is placed on the oral disk, the anemone partially contracts. This contraction is concentrated in the oral disk and occurs very rapidly (Fig. 1*B*).

2) In 2 to 3 seconds the oral disk, column, and tentacles extend fully.

3) After complete extension, the anemone begins a series of whirling motions, with the oral disk circling around the oral-aboral axis (Fig. 1*C*). One complete rotation takes approximately 1 second. After one or two rotations, the movement changes to a spasmodic, side-to-side movement of the oral disk and the upper part of the column.

4) Detachment from the substratum then generally occurs.

5) The swimming motions of the anemone involve a combination and intensification of undulatory movements of the oral disk, the column, and the base (Fig. 1*D* and Fig. 2*A,B,C*). Considerable thrashing is needed for any extensive progressive movement, suggesting that this mode of "swimming" is very inefficient. The direction moved appeared to be random. The longest distance traveled in a straight line that was observed during one swimming operation was 80 cm. Since this movement lasted 58 seconds, the anemone moved through the water at a rate of about 1.5 cm/sec. While the organism is actively swimming, the base is considerably distended and dome-shaped. At the center of the base is a conspicuous papillalike structure that appears to be important in facilitating quick detachment (Fig. 2*D*). Serial sections are being prepared to reveal whether there is a possible connection between the coelenteron and the underside of the basal disk through an aperture at the end of the papilla.

6) During swimming operations, the base of the anemone will sometimes touch the substratum, evoking an increase in the activity so that the animal may make several such momentary contacts before coming to rest.

7) With the cessation of the swimming motions, the anemone settles to the bottom, still fully extended, and comes to rest on its side. After a minute or two the elongated column flexes, the base attaches to the substratum, the animal rights itself, and the normal resting posture is resumed.

It is interesting to note that the immediate contact of the starfish apparently stimulates the swimming response to completion—there are no partial modifications. It may be that this complex reflex behavior is initiated by the anemone's chemoreceptors after stimulation by some substance from the starfish. This dramatic swimming reaction might be interpreted as an escape mechanism, since it is known that *Crossaster papposus* has been observed to feed on anemones (*3*). However, in the aquariums, during the course of these experiments, none of the species of starfish studied have been observed to feed on this or any other anemone. In addition Stevenson (*4*) observed that *Stomphia* became "restless, jerked and detached" when subjected to adverse conditions, such as the warming of the water within the aquarium.

Periodic locomotion involving creeping motions of portions of the pedal disk is rather common among actinians. Pantin and coworkers have shown that this type of locomotion, termed "walking," may be correlated with some stimulus in *Metridium*. Usually the walking response ensues after the animal has been stimulated adversely (*5*). Because of the long time periods required for this and other actinian responses, Batham and Pantin have termed them phasic.

The swimming response of *Stomphia* has obvious contrasts. (i) The activity is of a much shorter duration. (ii) The swimming activity requires the specific stimulus of the immediate presence of certain starfish or some substance from the starfish. (iii) The site of greater sensitivity of this stimulus appears to be in the region of the oral disk. Electric shocks applied midway on the column evoked the swimming response, but the means by which the sensory apparatus in the oral

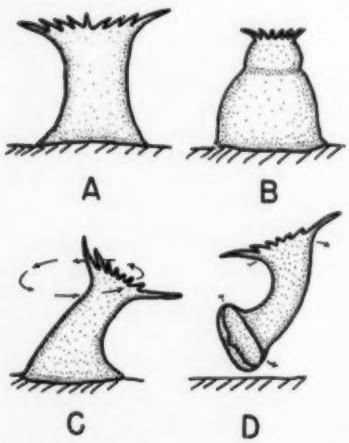

Fig. 1. Pertinent activities involved in detachment and "swimming" by the actinian *Stomphia coccinea*. (*A*) Anemone before contact with the starfish; (*B*) contact with starfish with the anemone partially contracting and a conspicuous sphincter constriction occurring near the oral end of the animal; (*C*) "whirling" motion of the anemone just prior to detachment; (*D*) complete detachment.

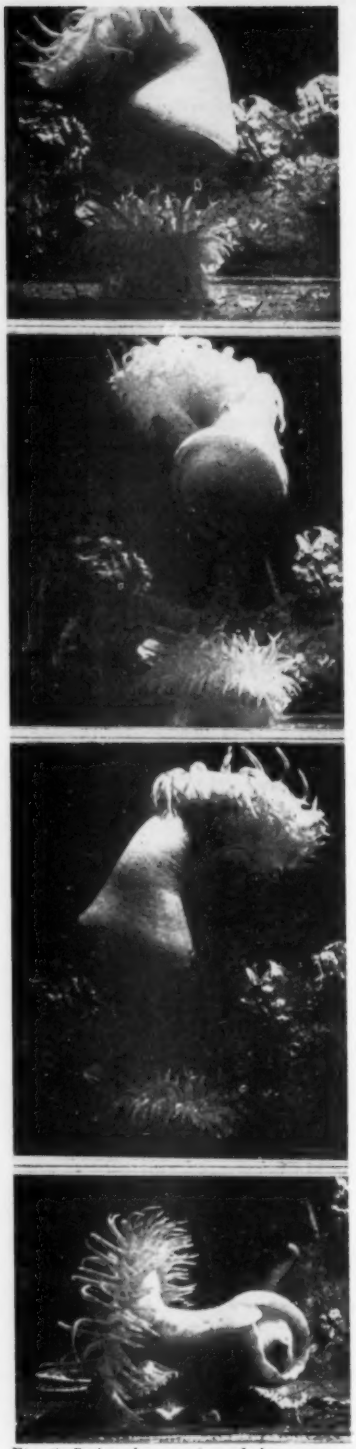

Fig. 2. Swimming motion of the anemone *Stomphia coccinea* shown in series of four frames from a motion picture (*2*). The time lapse between the first and third frame is approximately 40 seconds. In bottom frame note protruding pore in the basal disk.

end of the animal is excited by the electric impulse is not understood. (iv) The swimming response appears to have a rather specific threshold of stimulation. But to divorce this response completely from all phasic activity one would have to establish the existence of a specific receptor-effector mechanism for this response that could operate independently of phasic activities. The existence of such a mechanism in the simple actinian nervous system does not seem probable. A possible answer might be that the swimming response is a combination of accelerated phasic activities.

Figure 1 shows that the general motions of *Stomphia* are the same motions found in slower phasic activity. Likewise, this sequence of movements closely resembles that of the feeding activities of *Metridium senile* as described by Batham and Pantin. Therefore, the swimming response may be all the typical phasic activities in sequence accelerated to a high degree by the presence of the starfish or the starfish substance.

Further work is in progress at these laboratories; special emphasis is being placed on the description of the neuromusculature system of this anemone.

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1. This work was partly supported by Office of Naval Research contract N8onr-520/III with the University of Washington (Contribution No. 190 from the Department of Oceanography.) Acknowledgment is extended to Richard H. Fleming, executive officer, for the use of the departmental facilities; to M. P. Wennekens and E. E. Collias for their technical assistance, and to L. M. Passano and D. L. Ray for their many helpful suggestions during the preparation of this report.
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22 July 1955

Variations of Nitrogen-15 Abundance in Naturally Occurring Substances

It has been shown that the isotopic abundances of many of the lighter elements are not constant (*1*). This paper is a report of some measurements on the variation of the N^{15} abundance in a number of naturally occurring substances. The absolute abundance of N^{15} in atmospheric nitrogen has been measured to be 0.365 percent (*2*). The N^{15} to N^{14} ratio in the N_2 isolated from the samples has been compared directly with the ratio in standard atmospheric N_2, and the results are expressed as parts per 1000 difference from the N^{15} to N^{14} ratio in the standard:

$$\frac{(N^{15}/N^{14})_x - (N^{15}/N^{14})_{std.}}{(N^{15}/N^{14})_{std.}} \times 10^3$$

Protein nitrogen was reduced quantitatively to ammonium salts by the standard Kjeldahl digestion, followed by oxidation to N_2 by sodium hypobromite (*3*). Since this procedure alone did not yield sufficiently pure samples, the N_2 was purified by repeated passage over Cu–CuO at 700°C in a carefully outgassed quartz furnace attached to a liquid nitrogen trap.

Inorganic nitrates were quantitatively reduced to ammonium salts by reduction with iron in dilute sulfuric acid (*4*), followed by oxidation to N_2 and purification. The N_2 from natural gas was isolated by passing the gas through a liquid nitrogen trap and then cycling the noncondensable fraction over hot CuO–Cu at 700°C until a constant value for the N^{15} to N^{14} ratio was obtained. In several cases, the sample was separated from a large excess of helium by trapping the N_2 in charcoal at liquid nitrogen temperature and pumping off the noncondensed helium with a Toeppler pump.

The N_2 from rocks and minerals was obtained by heating 100-g portions of the

Table 1. Variations in N^{15} abundance compared with standard atmospheric N_2 of local origin.

Sample	Origin	Difference in N^{15}/N^{14} ratio from standard (parts per 1000)
	Plant protein	
Leaves, white clover	Local	− 6.5
Leaves, dandelion	Local	− 2.8
Leaves, red oak	Local	− 0.9
Leaves, cedar	Local	1.3
Leaves, American elm	Local	1.9
Weeds	Local	4.3
Oats	Unknown	6.2
Seaweed	Tokyo Bay, Japan	8.1
	Animal protein	
Egg, domestic chicken	Local	5.8
Clam flesh	Atlantic Ocean	7.3
Lamb flesh	Unknown	5.0
Milk	Local	5.1
White rat, brain tissue	Local	5.4
White rat, lung tissue	Local	7.5
White rat, liver tissue	Local	4.5
White rat, blood	Local	6.2
White rat, skin and hair, thorax	Local	5.0
	Peat and coal	
Peat	Eire	1.9
Peat	Junius, N.Y.	− 2.8
Lignite	Bowman, N.D.	− 1.2
Bituminous coal	Pittsburgh, Pa.	− 0.9
Cannel	Cannel City, Ky.	1.6
Anthracite	Gunnison, Colo.	− 1.2
Anthracite	Lehigh, Pa.	− 1.4
	Oil and gas wells	
Ella Well	Hunton Lime Formation, Okla.	− 8.1
Plaisted No. 1	Marchand Formation, Okla.	− 3.5
Steve No. 1	Upper Bradley Formation, Okla.	− 8.2
Steve No. 1	Lower Bradley Formation, Okla.	2.9
Fletcher No. 10	Marchand Formation, Okla.	− 7.6
Bitt No. 1	Hart Formation, Okla.	− 11.5
Matheson 96-percent methane	Unknown	− 13.0
Natural gas	Washington County, Ark.	− 5.9
	Rocks and Minerals	
Granite	Chelmsford, Mass.	− 0.2
Granite	Milford, Mass.	− 0.9
Pitchblende	Great Bear Lake, Canada	− 2.3
	Inorganic nitrogen	
Chile nitratite	Tarapaca, Chile	− 2.6
Sal·ammoniac	Paracutin, Mexico	13.0

powdered sample with CuO at 750°C for 4 hours in a carefully evacuated and outgassed Vycor flask that was connected to the vacuum system. The evolved gases were passed through a trap at liquid nitrogen temperature and treated with hot CuO–Cu. The standard atmospheric nitrogen was isolated from air by passing air repeatedly over cleaned copper turnings in a quartz tube at 700°C and then through a liquid nitrogen trap.

The mass spectrometer is of the design described by several workers for the measurement of small differences in isotope ratios (*5*). Mass spectrometry of nitrogen is troubled by the presence of background peaks in the instrument at mass 28 and 29. The background peaks were less than 0.1 percent the size of the signal peak at mass 28. The procedure of rapidly shifting from the standard nitrogen sample to the unknown sample minimized the effect of this background. It is imperative that N_2 samples be free of carbon monoxide, which gives an interfering mass spectrum. This problem was solved by passing the gas over hot CuO and through a liquid nitrogen trap. Several samples were prepared and their N^{15} content was measured both before and after repeated treatments in this manner. There was no detectable change in the N^{15} content.

In order to avoid isotopic fractionation in sample preparation, all operations were checked to insure quantitative yields. The estimated precision on each of the results listed in Table 1 is ±0.5 parts per 1000.

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21 July 1955

Differentiation and Separation of the Tetracycline Antibiotics by Countercurrent Distribution

Recently, the discovery of tetracycline (*1*) in *Streptomyces* elaboration products has increased interest in methods designed to differentiate among the members of this family of compounds.

In the past, various procedures (*2–6*) have been reported for carrying out such a differentiation; these methods are for detection only and have as yet had no extension into the field of separation.

The countercurrent distribution system consisting of McIlvaine's phosphate-citrate buffer at *p*H 4.5 versus chloroform has been used in these laboratories for some time for the analytic separation of mixtures of the known tetracycline antibiotics. In a 50-tube distribution with this system, the peak tubes observed are as follows: chlortetracycline 26, tetracycline 39, and oxytetracycline 44. These values correspond to K aqueous/solvent values of 1.13, 3.90, and 8.80, respectively.

Pigments with a strong absorptive capacity in the ultraviolet, such as anhydrotetracycline (*7*), usually localize in the low-numbered tubes because of their excellent solubility in chloroform; thus their presence does not interfere with the ultraviolet determination of the peak tubes, which is carried out on the upper phase at a wavelength of 265 mμ after suitable dilution.

After the theoretical curves for each component have been calculated, the percentage composition of a mixture such as one containing tetracycline and chlortetracycline can be calculated within a few percent of the bioassay, via the peak heights as determined spectrophotometrically.

The method has been used not only on purified preparations but also on crude preparations, such as those obtained from butanol extractions of fermentation beers. Samples assaying 300 to 500 μg/mg have given satisfactory results in the identification of major components (not traces) when as little as 3 to 5 mg was placed in the first tube of a 50-tube apparatus containing 10 ml of each phase. If larger samples are used, as little as 1 percent chlortetracycline in tetracycline can be detected.

A change in *p*H from 3.5 to 5.5 seems to have little effect on the position of the peak tubes. Since the buffer can be made up in the range of *p*H 2.2 to 8.0 and since the solubility of the tetracyclines increases sharply at lower *p*H values, higher charges can be accommodated at a slightly lower *p*H (for example, 3.5). By the use of such higher concentrations in a larger apparatus, sufficient material can be handled to give a useful separation.

This method will be described in more detail in a forthcoming publication (*8*).

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24 June 1955

Localized Electroretinograms from Isolated Poikilothermic Retinas with Macroelectrodes

What effect does the stimulation of some retinal elements have on the effect of stimulating others? Is there a real effect, or only an apparent one caused by stray light, chiefly from scattering in the dioptric media of the eye?

The interchangeable effects of stimulus area, duration, and intensity on the electroretinogram (ERG) of the intact frog eye were considered by Granit (*1*) to be evidence for interaction of retinal elements. Fry and Bartley (*2*), using the intact rabbit eye, showed that stray light could explain the apparent interaction and that, indeed, the ERG was mainly a response to stray light within the eye. Granit, Rubinstein, and Therman (*3*) obtained results apparently supporting interaction when they minimized stray light by using small stimuli of low intensity in an excised and opened frog eye. Recently, the stray light theory of Fry and Bartley has been revived and confirmed for the human ERG (*4*). This, together with the inconclusive character of the evidence for retinal interaction, raises several questions regarding the effects that stimulation of one retinal locus may have on the response from another locus.

We have recorded ERGs from isolated frog (*Rana pipiens* and *R. catesbeiana*) and terrapin (*Pseudemys elegans*) retinas. We removed the retina under subdued illumination and placed it flat on a black felt pad that had been soaked in Ringer's solution. The preparation was placed in a black box to minimize further any effects from stray light. Thread wicks from silver-silver chloride electrodes were led to any desired points on the surface of the retina, and another to the supporting pad. Two channels of alternating-current amplification led to a dual-beam cathode-ray oscilloscope and permitted simultaneous registration of potential changes that occurred between two pairs of electrodes, if desired, or between one pair of electrodes if the second beam was used for a time scale and stimulus marker.

Each stimulus was a 1-mm spot of light of adjustable intensity and duration. Two such spots can be presented at any

desired retinal locations and with any desired timing.

With a single spot of 50 msec duration and intensity as high as 1×10^6 ft-lam, we have found the ERG to be extremely localized. When the supporting pad is the indifferent electrode, an ERG is registered only when the thread wick is at the locus illuminated. The response (*a*-wave plus *b*- or *x*-wave) may then be more than 100 μv but generally is less, depending on the retinal locus and the age of the preparation. Moving either the light spot or the wick as little as 1 mm extinguishes the response to at least below the noise level of about 3 μv.

By systematically moving the light spot together with the thread electrode to various retinal loci, we have been able to map the retina electroretinographically. Such a map reveals a functional outline of the optic disk, within which no response can be obtained. It also outlines the retinal margin where the response again falls to zero. Curiously, although we have found a definite increase in sensitivity from the periphery toward the center of the retina, it is not a smooth gradient. Instead, "peaks" and "valleys" of high and low sensitivity appear to exist. It is possible that these are artifacts caused by trauma of preparation, although no other evidence of physical injury can be found. Actual tears in the retina completely eliminate the ERG at the site of the injury.

Early investigators (*5*) cited by Granit reported rapid disappearance of the *b*-wave when the frog retina was removed from the bulb (although, to be sure, they were using less responsive apparatus). Our preparations have yielded apparently normal ERGs for more than 5 hours of experimentation, at times with little evidence of any deterioration or significantly decreased responses. Responses at a given locus are repeatable from one time to another within about 20 percent when the total height of the ERG is measured from the trough of the initial negative wave (*a*-wave) to the crest of the first positive wave (*b*- or *x*-wave). During an experimental session, the preparation was moistened occasionally with Ringer's solution to prevent drying. The use of isotonic glucose does not appear to enhance the response or to prolong the usefulness of the preparation.

Despite the differences in technique, especially the localized recording described here, we have been able, although not consistently, to confirm the inhibition of Granit, Rubinstein, and Therman.

Using two stimulus spots spaced 2 to 3 mm apart on the retina, we did not find any effect of one stimulus on the ERG registered from the retinal locus of the other spot, regardless of the time relationship of the two flashes. With the spots very close together (½ to 1 mm), however, evidence of interaction has been noted. Stimulating one spot alone produces no recordable response at the retinal locus of the other spot, but may *inhibit* the ERG response to stimulation of the second locus for many seconds afterwards. The recovery of the inhibited locus may be observed by repeatedly stimulating that locus and noting the progressive increase in potential throughout the ERG. Thus it appears that interaction of the ERG takes place over small distances on the retina but not over large ones.

Investigation of these and similar phenomena is continuing and a more complete report will be submitted for publication elsewhere. However, we wish to invite attention at this time to this relatively simple technique of registering localized ERGs without the use of microelectrodes.

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29 July 1955

Vegetative Changes at Pinacate, Sonora, Mexico

Since 1931, a considerable area at Pinacate, Sonora, Mexico (Fig. 1)—which has certainly been barren of vegetation since 1907–09 (*1*), almost certainly barren of vegetation since 1774–76 (*2*), probably barren since 1697–1701 (*3*), and possibly barren since 1541 (*4*)—has acquired a surface cover of grasses and has developed a soil profile up to 2 inches thick in some places.

Surface material at Pinacate formerly consisted of basaltic lava flows, volcanic cinders, volcanic ash, and saline playa deposits. All areas except lava flows now show some soil profile development, most of the soil consisting of roughly equal parts of local materials (cinders, ash, or playa deposit), blow sand (calcareous), and organic material of recent local origin.

Known factors contributing to the growth of surface cover are (i) slight increase in annual precipitation; (ii) decline in intensity of precipitation (more days with rain, less rain per day); (iii) an increase in winter (gentle) rainfall; and (iv) virtual extinction of mountain sheep and wild burros in the area.

Fig. 1. Summary outline map of southwestern North America showing the location of the Pinacate region.

During the last decade, many of the plunge-pool water holes in the area ("tinajas") have been dry repeatedly, indicating a decline in the cloudburst type of precipitation that refills them; but dry farming in areas just south of Pinacate has been occasionally profitable, suggesting greater soak-in of precipitation.

Many of the larger cinder cones adjacent to the main Pinacate Peaks now support a new growth of cholla cactus (*Opuntia Bigelovii*), all of the cacti being of uniform height and having an estimated age of about 10 years. As a result of these vegetative changes, the Pinacate lava region, when seen from a distance on the ground or viewed obliquely from the air, now has a distinctly green tinge, in place of the dark grays, dull reds, and blacks of former decades.

The cause of this somewhat localized vegetative change is not surely known, although increase in rainfall and alteration of its seasonal distribution and intensity are certainly important factors. It is possible that some of this climatic change is "carryover" from cloud-seeding operations in the mountains east of San Diego.

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15 July 1955

Book Reviews

Engineering Metallurgy. L. F. Mondolfo and Otto Zmeskal. McGraw-Hill, New York–London, 1955. ix + 397 pp. Illus. $7.50.

For some time there has been a need for a survey textbook in metallurgy for mechanical, chemical, and electrical engineers, because metallurgy has become such a dynamic field that the textbook writers have been unable to keep pace with the newest developments. Such a book is *Engineering Metallurgy,* which was written by two men who have had a great deal of personal experience with the subject matter while teaching at the Illinois Institute of Technology. The more recent developments have been worked in skillfully with the thoroughly understood fundamentals to produce a textbook that is a good guide for serious study as well as a survey of the science of metallurgy.

The presentation of the material is in logical sequence, beginning with a general discussion of the origin and extraction of metals from their ores that avoids getting lost in details about individual metals. The next three chapters take up the theory of alloys, giving special attention to phase diagrams in order to make easier a difficult subject for most beginning students. Both binary and ternary systems are discussed in detail. Two chapters cover some of the problems of melting and casting and are followed by two chapters on the principles of plastic deformation, work hardening, and recrystallization. A general discussion of phase transformations in the solid state and their effects on the properties of alloys is given, and four chapters are devoted to the more specialized topics of heat treatment, joining, powder metallurgy, and corrosion. The two final chapters briefly discuss commercial metals and alloys. Throughout the book emphasis is placed on principles rather than on descriptive details about specific metals.

There are obvious limitations on any book of this kind in that a choice must be made beween completeness and brevity. Although principles must often be stated without proof in a textbook such as this, these authors have given more than adequate references for further study where space prevented full explanation. In addition, a fine set of problems is given at the end of each chapter to challenge the student's ingenuity. This textbook should be helpful to anyone who wants a general knowledge of metallurgy and is certain to be widely used in engineering colleges everywhere.

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Basic Processes of Gaseous Electronics. Leonard B. Loeb. Univ. of California Press, Berkeley, 1955. xvii + 1012 pp. Illus. $13.50.

The stated purpose of this book is to present basic facts by which the properties of electric conductivity in gases can be understood. These properties include not only the conduction process and the breakdown process but also their relationship to all the environmental features that control these phenomena. The surface properties of the surroundings, including the electron emitters and collectors, are described and related to the conduction characteristics of the system. The flow of electrons through gases and, as the electron energy increases, the reactions and the results of this flow are described in considerable detail. The products of these reactions include excited and ionized atoms and molecules, which in turn react on other molecules or at surfaces to become neutralized and often generate additional electrons in the process.

This incomplete résumé is too brief to describe the range in subject matter dealt with in this book. It serves, however, to forewarn the reader that a comprehensive analysis of such a vast subject as gaseous electronics must of necessity cover so many intricate problems of physics that one person cannot expect to handle it adequately enough to meet present-day needs. L. B. Loeb did recognize this need for expert assistance in certain fields and obtained the very able cooperation of S. C. Brown of the Massachusetts Institute of Technology and G. H. Wannier, G. P. Molnar, and J. A. Hornbeck of the Bell Telephone Laboratories, who prepared limited sections of the book dealing with the subjects in which they are individually leading experts.

It was the intention of the author not only to present the basic facts but to do it in such a manner that the book could be used both as textbook material for instruction and as reference material for engineers and physicists. It was also assumed that such readers would not be well acquainted by advanced preparation with the necessary theoretical background required for a clear understanding of the complex phenomena involved. In my opinion that ambition to satisfy the needs of the readers is not realized.

A few specific points will serve to clarify the meaning of this criticism. Throughout the book there is considerable confusion of symbols, and at the same time there is no assembly of the definitions of symbols that will permit the reader to know with certainty the particular meaning intended on a particular page or in a particular equation in the text. For efficient use of a book as a reference it is necessary that the reader be able to obtain the correct definitions of symbols quickly. In general, the units used relate to the cgs system, and yet in some of the equations that involve such matters as work-function and the like there is such a mix-up of units that it would be extremely difficult for the uninitiated to use the equations for quantitative calculation. In addition to this confusion of units, there are an unusually large number of typographic and simple factual errors that have been overlooked because of inadequate editing as well as carelessness in proofreading.

Elementary results that come from classical kinetic theory are made unnecessarily mysterious by the relating of one average property of ideal gases to another average property, such as the average speed of the particles distributed in speed according to the Maxwell-Boltzmann distribution function. If the various averages had been related directly to the basic distribution function itself, the text would have been easier to understand and to teach. This fact may possibly explain why the treatment of probe theory is extremely weak. The discussion of space charge in its relation to probe theory and as it relates to the emission properties of heated cathodes is completely inadequate for the instruction of either the student or the engineer who wishes to apply the knowledge of these phenomena to problems of importance in gaseous electronics. The section on thermionic emission and field emission as it relates to the delivery of electrons into a gas discharge is poorly presented and therefore in many respects misleading.

The bibliography is extremely exten-

sive but not too easy to use. The method of putting it at the end of each chapter has both advantages and disadvantages. Unfortunately, one of the major advantages seems not to have been recognized. With the references at the end of the chapters, it is not necessary to enter them chronologically as the references appear in the text. It would therefore have been much better if the author had entered his references alphabetically with respect to the authors involved.

In spite of the serious drawbacks associated with the production of this extensive treatment on gaseous electronics, it brings together a review and an analysis of much information derived from many years of study, instruction, and research in this difficult branch of the general subject of physical electronics. Anyone who acquires the book and who has some knowledge of the subject will not deny that it represents a great effort to put in order the basic facts relating to a complex subject.

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Radio Astronomy. International monograph on radio. J. L. Pawsey and R. N. Bracewell. Oxford Univ. Press, New York–London, 1955. x + 361 pp. Illus. + plates. $8.80.

Radio astronomy is by now more than 20 years old, but until the appearance of the present volume there existed only a single semitechnical work on the subject, the book by Lovell and Clegg (1952). Some of us who have been teaching courses in the field have had our course notes mimeographed, but no printed textbook was available. The Pawsey-Bracewell volume is our first textbook and a good one it is. It has been written by the assistant chief and a member of the staff of the famous Radio Physics Laboratory in Sydney, Australia. Above all, it bears witness to the fruitfulness of the research in radio astronomy in Australia, which has provided a strong impetus to the postwar development of this new science.

After a brief, mostly historical, chapter, the book starts off in earnest with a very readable general survey of techniques of observation, a survey that will be especially appreciated by astronomical readers who need and desire such guidance. The sections on aerials, on calibration, and on interferometers (which includes the Mills pencil-beam radiometer) will be read and studied with care by many who are new in the field.

The book apparently has been directed primarily at the physicists and radio engineers, who are newcomers to the mysteries of astronomy. After a brief chapter on radio waves in ionized gases, there follows a lengthy one on aspects of optical solar physics relevant to radio astronomy, and a little later in the book we find a similar chapter on optical astrophysics and our own and other galaxies. At the present stage of development of radio astronomy this is probably all to the good.

The two chapters of greatest length are on solar radio waves and on cosmic radio waves. The first of these bears considerable similarity to the fine chapter on solar radio emission (by Pawsey and Smerd) in Kuiper's recent comprehensive volume on *The Sun*, but this in no way detracts from its value. The other chapter—on cosmic radio waves—is, alas, a little on the brief side, and here the book suffers markedly from a delay in prompt publication: whole sections are more or less out of date, in part because of more recent work by the authors and their associates. It is difficult to avoid this in a field that is still developing as rapidly as radio astronomy is. To take one glaring example of rapid "ageing": there is no reference in the sections dealing with 21-centimeter research to the recent spectacular results on the spiral structure of the galaxy, to the absorption features observed in the profiles of some discrete sources, or to studies relating optical and 21-centimeter features of details of the interstellar medium. In other words, the eager student of the subject will perforce have to depend on recent summarizing articles or volumes like the forthcoming one resulting from the August 1955 symposium held at Jodrell Bank, if he wishes to be up to date in the field. The same criticism applies to problems related to the radio continuum or the identification of discrete radio sources.

The concluding chapters of the book deal with thermal radiation from the moon, radio echo techniques and their application, and a brief survey of the field of radio studies of meteors. A brief chapter on effects of the earth's atmosphere completes the technical presentations.

The Pawsey-Bracewell volume is the first real textbook in radio astronomy, and the authors deserve the thanks of colleagues and students for their courage in attempting to write a textbook at a time when the field is still changing from month to month. Let us hope that the first edition may soon be sold out, that the authors may be persuaded to prepare an up-to-date second edition, and that the publishers will bring the next edition out with minimum delay.

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Nuclear and Radiochemistry. (Revised version of *Introduction to Radiochemistry.*) Gerhart Friedlander and Joseph W. Kennedy. Wiley, New York, 1955. ix + 468 pp. Illus. $7.50.

When this book appeared in 1949, it became deservedly one of the textbooks most widely used by teachers and students seeking a thorough but not overelaborate and expensive introduction to "radiochemistry." The authors stated that they included in this term the "reactions of nuclei and the properties of resulting nuclear species . . . the field of chemical studies with the use of isotopic (radioactive) tracers, including studies of essentially pure tracers at extremely low concentrations." The passage of 6 years has only served to emphasize the wisdom and skill of Friedlander and Kennedy in their choice and integration of subject matter. We are fortunate to have at hand a new edition, written to bring up to date the older material and to take cognizance of some changes in emphasis brought about by the rapid development of the fields just cited. These changes are evident in the new title distinguishing nuclear chemistry from radiochemistry.

The organization of the new volume follows rather closely that found so effective in the first edition. New material is skillfully woven into the fabric of the old. Essentially chemical material appears earlier in the new version. The problem sets have been supplemented effectively by others designed to give the student the increased understanding resulting from the incorporation of new material. An added feature is the inclusion at the end of the book of two new chapters dealing with nuclear energy, both in its civil and military applications, and cosmic aspects of nuclear chemistry.

The expansion of the text has been counteracted by using smaller type and employing a larger format, with no appreciable loss in legibility.

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The Negro in Science. Julius H. Taylor, Ed. Morgan State College Press, Baltimore, 1955. viii + 192 pp. $3.50.

In a more rational society there would be no need for a book on the Negro in science. But discrimination, poorer opportunity for education, and the absence of tradition and environment conducive to the development of research interests have combined to make the Negro in science a rarity—a rarity among Negroes and a rarity among scientists. Yet the

Negro who overcomes the barriers is capable of good scientific work. Most of this volume consists of reprints of published papers by Negro biologists, chemists, mathematicians, and physicists. By examining the papers one could tell nothing about the color of their authors.

The volume was published to mark the dedication of the science quadrangle at Morgan State College. The event symbolizes a trend. Negro colleges have trained remarkably few scientists, partly because scientific facilities have been poor and scientific interests low. Now, however, facilities are improving and interest is growing. But even if opportunities at the college level were exactly the same for Negro and white students, the lasting effects of poorer environments and earlier education would lead to under-representation of Negroes among the ranks of scientists. In the one paper written expressly for this volume, Herman Branson, chairman of the department of physics at Howard University, gives an excellent brief account of the sociological factors responsible for the rarity of Negro scientists.

Some of the material in the book gives encouraging evidence that the number of Negro scientists is increasing. There is a very brief account of the trend toward greater scientific interest in Negro colleges. There is also a biographical directory of Negro scientists. They average a few years younger than a sample of the men and women listed in the most recent volume of *American Men of Science*. More striking is the high concentration in the younger age brackets. A fifth or more of the men and women in *American Men of Science* were born before 1900; only 8 percent of the Negro scientists are as old.

The trends are encouraging, but there is not yet equality of opportunity. Until there is, America will be wasting a good portion of its needed intellectual resources.—D.W.

Metals Reference Book. vols. I and II. Colin J. Smithells. Interscience, New York; Butterworths, London, 1955. xvi + 531 pp. and xv + 434 pp. Illus. $25.

This book attempts to provide a convenient summary of data related to subjects ranging from metal physics through inorganic chemistry and various branches of physical and applied metallurgy. The first edition, which appeared in 1948, has now been followed by a second edition that is thoroughly revised and enlarged. The two new volumes cover data collected by more than 60 contributors.

The first 45 pages of volume I contain tables of weights and measures, temperature, various conversion factors, and mathematical formulas as well as general physical and chemical constants. These are followed by two chapters on properties of atomic nuclei and line spectra of elements. A chapter on x-ray crystallography deals with various methods and data useful for determination of the crystal structure and is followed by a chapter on structure and structural details of metals and innumerable intermediate phases. The remaining part of volume I contains some information on geochemistry, a comprehensive chapter on metallographic identification of various phases in metals and alloys, and about 230 pages on binary and ternary equilibrium diagrams.

Volume II begins with a chapter on gas-metal systems, including solubility data, and is followed by a completely rewritten chapter on diffusion in metals. New chapters included in this volume contain data on elastic properties and damping capacity, physical properties of molten salts, and friction. About 50 pages are devoted to a completely rewritten chapter on thermochemical data and almost the same amount to chapters on various physical properties of metals and alloys. A short chapter on magnetic materials precedes a comprehensive collection of data on mechanical properties of industrial metals and alloys. The remaining 160 pages of volume II contain data and information pertaining to fields of applied metallurgy, such as deep drawing, lubrication, various foundry data, heat treatment, corrosion, and welding.

The two volumes contain an enormous amount of information, and I have noticed only one or two small errors or typographic mistakes in chapters in which the data is more familiar to me. Considering the unusual difficulties in producing a book of this kind, a very high standard in both preparatory and publishing stages is shown. I am sorry to see the examples of typical compounds removed from the table that deals with structural details of various metallic compounds, and if mathematical tables are to be included I would prefer a few pages devoted to logarithms of numbers rather than to solution of integrals and differential equations, for which I would look in mathematical reference books.

Many equilibrium diagrams are drawn to a larger scale than in the first edition and are now preceded by useful interconversion tables of atomic and weight percentages in binary systems. The details of many diagrams based on the book by M. Hansen published in 1936 are now out of date, and where diagrams are modified by later references their choice is somewhat arbitrary. Perhaps it would be helpful in subsequent editions to state when the survey of references was completed before publication.

The extended bibliography at the end of each chapter is a welcome improvement in this new edition, although in chapters that deal with crystal structure and equilibrium diagrams the bibliography is still far from complete.

On the whole the two volumes are comprehensive, extremely valuable, and almost indispensable to workers in the practical fields dealing with metals and alloys.

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Theory of Functions of a Real Variable. I. P. Natanson. Trans. by Leo F. Boron and Edwin Hewitt. Ungar, New York, 1955. 277 pp. Illus. $6.50.

The original Russian text (issued in 1941) contains 17 chapters. In the present book the first nine of these chapters were translated. (A German translation of the entire work was published in 1954.) This English edition is a useful and valuable, clearly written, and easily readable textbook. After an introduction to general sets and to linear point sets (Chapters I and II), the measure of linear sets, the measurable functions, and the Lebesgue integral are treated (Chapters III–VI). Then (in Chapter VII) Hilbert space, mean convergence, and orthogonal systems of functions are discussed. A chapter (VIII) on functions of finite variation and Stieltjes integrals and a chapter (IX) on absolutely continuous functions and the indefinite Lebesgue integral conclude the book.

It is rather strange that in the Russian text all unbounded sets are considered nonmeasurable. There, measurability is defined only for bounded sets without even indicating the simple generalization to the case of unbounded sets. For this reason appendixes to Chapters III, IV, VI, and VII were supplied by E. Hewitt. (Moreover, his appendix to Chapter IX considers functions of finite variation on the infinite line.)

Chapters X–XVII of the original Russian text, whose translation is not included in the present English edition, discuss singular integrals and trigonometric series, point sets in the plane (rather late!), measurable functions of several variables and their integration, set functions and their application in the theory of integration, transfinite ordinal numbers and Baire's classes of functions, as well as normed linear spaces. A final chapter states the role of Russian mathematicians in the development of the the-

ory of real functions. It would also certainly be worth while to translate into English a good many of the remaining chapters of the Russian text.

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New Books

Topsoil and Civilization. Tom Dale and Vernon Gill Carter. Univ. of Oklahoma Press, Norman, 1955. 270 pp. $3.95.

Instrument Engineering. vol. III, *Applications of the Instrument Engineering Method;* pt. 1, *Measurement Systems.* Charles Stark Draper, Walter McKay, and Sidney Lees. McGraw-Hill, New York, 1955. 879 pp. $17.50.

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Niels Bohr and the Development of Physics. Essays dedicated to Niels Bohr on the occasion of his seventieth birthday. W. Pauli, Ed. McGraw-Hill, New York; Pergamon, London, 1955. 195 pp. $4.50.

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Theory of Games as a Tool for the Moral Philosopher. An inaugural lecture delivered in Cambridge on 2 December 1954. R. B. Braithwaite. Cambridge Univ. Press, New York, 1955. 75 pp. $1.25.

Vitamins and Hormones. vol. XIII, *Advances in Research and Applications.* Robert S. Harris, G. F. Marrien, and Kenneth V. Thimann, Eds. Academic Press, New York, 1955. 382 pp. $9.

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Electronic Transformers and Circuits. Reuben Lee. Wiley, New York, and Chapman & Hall, London, ed. 2, 1955. 360 pp. $7.50.

Reflections of a Physicist. P. W. Bridgman. Philosophical Library, New York, ed. 2, 1955. 576 pp. $6.

Research Frontiers in Politics and Government. Brookings lectures, 1955. Stephen K. Bailey, Herbert A. Simon, Robert A. Dahl, Richard C. Snyder, Alfred de Grazia, Malcolm Moos, Paul T. David, and David B. Truman. Brookings Institution, Washington, 1955. 240 pp. $2.75.

Acculturation. Critical abstracts, North America. Stanford Anthropological Ser. No. 2. Bernard J. Siegel, Ed. Stanford Univ. Press, Stanford, Calif.; Geoffrey Cumerlege, Oxford Univ. Press, London, 1955. 231 pp. $4.

The ISCC–NBS Method of Designating Colors and a Dictionary of Color Names. NBS Circular 553. National Bureau of Standards, Washington 25, 1955 (Order from Supt. of Documents, GPO, Washington 25). 158 pp. $2.

Aeroelasticity. Raymond L. Bisplinghoff, Holt Ashley, and Robert L. Halfman. Addison-Wesley, Cambridge, Mass., 1955. 860 pp. $14.50.

A Solomon Island Society. Kinship and leadership among the Siuai of Bougainville. Douglass L. Oliver. Harvard Univ. Press, Cambridge, Mass., 1955. 533 pp. $10.

Learning Across Cultures. A study of Germans visiting America. Jeanne Watson and Ronald Lippit. Inst. for Social Research, Univ. of Michigan, Ann Arbor, 1955. 205 pp. $3.

Functional Analysis. Frigyes Riesz and Béla Sz.-Nagy. Trans. from French ed. 2 by Leo F. Boron. Ungar, New York, 1955. 468 pp. $10.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Fishes of the Family Percophididae from the Coasts of Eastern United States and the West Indies, with Descriptions of Four New Species. Proc. U.S. Natl. Museum, vol. 104, No. 3347. 17 pp. *An Anatomical Study of the Peregrine Megascolecid Earthworm Pheretima Hupeiensis in the Eastern United States.* vol. 105, No. 3351. William C. Grant, Jr. 15 pp. *Populations of the Berycoid Fish Family Polymixiidae.* vol. 105, No. 3356. Ernest A. Lachner. 17 pp. *The Honey-Guides.* Bull. 208. Herbert Friedmann. 292 pp. Smithsonian Institution, Washington, 1955.

Social Science and Freedom, a Report to the People. Eighth in a series of annual public lectures on problems of current interest in the social sciences, and of particular interest to the citizens of Minnesota. Social Science Research Center of the Graduate School, Univ. of Minnesota, Minneapolis, 1955. 59 pp.

Scientists of Mexico. UNESCO, Center of Scientific Cooperation for Latin America, Montevideo, Uruguay, ed. 2, 1955. 363 pp.

The Blowflies of California, (Diptera: Calliphoridae). Bull. of the California Insect Survey, vol. 4, No. 1. Maurice T. James. 34 pp. $0.50. *The Carpenter Bees of California, (Hymenoptera: Apoidea).* No. 2. Paul D. Hurd, Jr. 37 pp. $0.50. Univ. of California Press, Berkeley, 1955.

The Schizaeaceae of the South of England in Early Tertiary Times. Bull. of the British Museum (Natural History) Geology, vol. 2, No. 7. Marjorie E. J. Chandler. 24 pp. 15s. *A List of the Gold Coast Pteridophyta.* Bull. of the British Museum (Natural History) Botany, vol. 1, No. 6. C. D. Adams and A. H. G. Alston. 43 pp. 12s. *Some Himalayan Fungi.* Bull. of the British Museum (Natural History) Botany, vol. 1, No. 7. Frances L. Balfour-Browne. 30 pp. 10s. *The Morphology of the Head of the Hawfinch, (Coccothraustes Coccothraustes), with Special Reference to the Myology of the Jaw.* Bull. of the British Museum (Natural History) Zoology, vol. 2, No. 13. R. W. Simms. 25 pp. 8s. *The Polychaete Fauna of the Gold Coast.* Bull. of the British Museum (Natural History) Zoology, vol. 3, No. 2. Norman Tebble. 90 pp. £1. *A Revision of the Family Epicriidae (Acarina—Mesostigmata).* Bull. of the British Museum (Natural History) Zoology, vol. 3, No. 4. G. Owen Evans. 32 pp. 10s. British Museum (Natural History), London, 1955.

National Tuberculosis Association, Annual Report, April 1, 1954 to March 31, 1955. The Association, New York 19, 1955. 45 pp.

Forest Research in India 1950–51. pt. 1, *The Forest Research Institute.* Govt. of India Press, Delhi, 1955. 127 pp. 15s.

A Restudy of the Needs of California in Higher Education. Prepared for the Liaison Committee of the Regents of the University of California and the California State Board of Education. California State Dept. of Education, Sacramento, 1955. 473 pp.

Scientific Meetings

Physiology of Invertebrates

A conference on Recent Advances in the Physiology of Invertebrates was held 12–16 September at the University of Oregon in Eugene; it was attended by about 40 invited guests. The meeting was sponsored by the University of Oregon, the Tektronix Foundation, and the National Science Foundation. It was originally planned by the University of Washington to be held in Seattle, but a number of the speakers who had been invited withdrew in protest over the action of the administration in connection with the proposed visit of J. Robert Oppenheimer last winter and the meeting was cancelled. At the invitation of the University of Oregon, the organizing committee composed of B. T. Scheer, chairman, L. H. Kleinholz, A. W. Martin, and T. H. Bullock, reopened plans.

The subjects discussed covered a wide but by no means comprehensive assortment of topics, with particularly strong representation from the areas of neuromuscular physiology, the effects of hormones, and the management of body fluids and solutes.

T. H. Waterman (Yale) reported recent physiological work on the compound eye. Records of spike activity from the optic ganglia of crabs and lobsters giving strong indication of integrative interaction between ommatidia were received with particular interest. The sensory capabilities of *Daphnia* and a wide selection of marine zooplankters formed an element of special remark in the paper of E. R. Baylor (Michigan) on vertical migration. Responses to changes of 0.1 *p*H unit, to changes of 75 mm of water pressure, to slowly changing temperature, as well as to color, polarized light, x-rays, gamma rays, and oxidizing and reducing substances; differentiation of function between the compound and the nauplius eye, and the polarization of light by phytoplankters were among the points he described. L. M. Passano (Yale) surveyed the adaptations involved in prey-predator relationships, especially in lower invertebrates, and H. Mittelstaedt (Wilhelmshaven) analyzed the accurate strike of the preying mantid in food capture in terms of the interaction of sensory input from eyes and neck proprioceptors and motor output to neck and leg muscles. T. H. Bullock (U.C.L.A.) summarized the properties and mechanisms that may account for integration at the level of small groups of neurons, analyzing as examples the formation of patterned bursts by the cardiac ganglion of lobsters and the discrimination between signal and noise in afferent centers.

The rapid advances in analytic neurophysiology were well illustrated in the series of papers by G. Hoyle (Glasgow), E. G. Boettiger (Connecticut), J. W. S. Pringle (Cambridge), and C. A. G. Wiersma (California Institute of Technology) on the control of muscle in insects and crustaceans. Although but few muscles are involved and only 2 to 3 nerve fibers per muscle unit, the same movement is rarely executed twice in exactly the same way by the intact locust. Important progress has occurred in the understanding of fibrillar muscle, which contracts many times for each muscle action potential. A click mechanism is not essential, but a click can be introduced into a system that lacks it by the action of certain muscles. Tension-length curves at all phases of movement have elucidated the conditions that produce a separation of the contraction process from the excitation of the muscle membrane indicating a third process between these two. Pringle aroused much interest by offering a theory of synchronized ATP splitting at sites along contractile elements with unusually strong lateral bonds. A trend documented by each speaker, in particular by Wiersma, is the increased knowledge of locally differentiated modes of control among muscles and even within a single muscle.

F. A. Brown, Jr. (Northwestern) described his recent experiments on rhythms; he concluded that barometric pressure and cosmic ray cycles may be involved. A paper by C. L. Prosser (Illinois) that called for more work in fields of zoophysiology bordering on ecology and evolution elicited vigorous discussion pro and con.

Certain areas of invertebrate endocrinology, especially the effects on metabolism, growth and differentiation, neurosecretory sources, storage and release, and a suspected neural transmitter substance were discussed in papers by J. H. Welsh (Harvard), L. H. Kleinholz (Reed), D. Bodenstein (Army Chemical Center) and B. T. Scheer (Oregon). 5-Hydroxytryptamine was suggested by Welsh to be a normal excitatory transmitter in mollusks, but others wished to wait for more evidence. The recently discovered y-organ in crustaceans may produce a molt-accelerating hormone. Contradictory results of eyestalk removal in the same species of shrimp, reported from different laboratories, were discussed. The analysis of hormones and target reactivity has reached a level of considerable sophistication in insects, considering that the hormones must still be defined for the most part by their effects. A development of general interest is the denial, for decapod crustaceans, of the usual rule that energy metabolism draws in order upon glucose, glycogen, lipid, and protein; the first two appear to be involved only in chitin synthesis.

J. D. Robertson (Glasgow) reviewed the information available on ionic regulation in invertebrates from marine, brackish, and fresh water and emphasized the diversity among species of crustaceans and mollusks, for example in plasma K^+ and Mg^{++}, urinary NH_4^+, intra- to extracellular Cl^-, and anion deficit. The group was impressed by the opportunity for studies correlating membrane potentials and behavior with these data. A. W. Martin (University of Washington) illustrated the recent advances in quantitative physiology of excretory processes by measurements of filtration, reabsorption, and secretion in the giant African snail and an octopus. Long standing problems such as the pressure in the lumen of solenocytes, the meaning of different arrangements of nephridia, vacuole formation in excretory epithelia, and the sites of the differential movements of materials appear to be amenable to solution by extension of these methods.

The group, including discussants, felt that the occasion was unique in bringing together such a representation of physiologists of lower animals and that the intangible benefits justified consideration of future meetings at intervals. Visits to the university's physiological laboratories and to the Oregon Institute of Marine Biology on Coos Bay were enjoyable breaks in an intensive program. It is planned to publish the principal contributions in book form under the editorship of B. T. Scheer.

THEODORE H. BULLOCK

Department of Zoology, University of California, Los Angeles

Meeting Notes

■ The future course of engineering education was the theme of a conference of officials from 21 eastern colleges and universities that was held at New York University on 3 Dec. Some 250 delegates to the fall meeting of the Middle Atlantic Section, American Society for Engineering Education, discussed means of carrying out the recommendations of an exhaustive national ASEE report that was made after a 3-year study.

The key provision of the report is a recommendation for more basic studies, principally in physics and mathematics, in engineering programs. This would mean a reduction in the number of courses in highly specialized subdivisions of engineering fields.

■ The 1955 winter meeting on the Pacific Coast of the American Physical Society will take place at the University of Southern California, 28–30 Dec. This meeting is being held in connection with the 75th anniversary of the founding of the University of Southern California. In view of the occasion, F. D. Fagg, Jr., president of the university, will deliver a message of greeting at the APS banquet. His address will be followed by a talk by Lee A. DuBridge, president of California Institute of Technology on "Physicists wanted." The presiding officer will be R. T. Birge.

There will be 33 invited papers and 96 contributed papers. This has led to the scheduling of seven sessions of invited papers and ten sessions primarily of contributed papers.

The somewhat larger-than-usual number of invited papers is caused by the last-moment arrangement of a symposium on the antiproton. The symposium is listed as session K of the program, 2:45 P.M., 29 Dec. In the anticipation that this session will be better attended than most, it was decided to have no other papers after 2:45 on that afternoon. This arrangement necessitated some distortions in the time schedule for the rest of the program.

For additional information write to the local secretary for the Pacific Coast, W. A. Nierenberg, University of California, Berkeley 4, Calif.

■ The first International Congress of Human Genetics will be held in Copenhagen, Denmark, 1–6 Aug. 1956. Any person interested in human genetics, and especially in medical genetics, is invited to take part in the congress. A provisional program and further information may be obtained from the First International Congress of Human Genetics, University Institute for Human Genetics, 14, Tagensvej, Copenhagen, N., Denmark.

■ Many urgent problems concerning poliomyelitis vaccination were explored by a group of 12 medical scientists who met in Stockholm, Sweden, from 21 to 25 Nov. under the auspices of the World Health Organization. This was the first exchange of knowledge and experience on the subject among European, American, and South African research and health workers.

WHO organized the meeting in an effort to bring together sufficient authoritative information on the numerous problems associated with poliomyelitis to enable the organization to give sound practical guidance to national health authorities. The study group reviewed the facts now available from a number of countries relating to field trials of poliomyelitis vaccine, the laboratory testing of vaccines, and the problems of their production in large quantities.

Members of the study group participated as independent scientists and not as representatives of their governments. They met in closed committee, and their recommendations will be addressed to the director-general of WHO.

Jonas E. Salk of the University of Pittsburgh School of Medicine had accepted an invitation to the meeting, but at the last moment he was prevented from attending; however, he contributed a working paper for the group's consideration. The other persons invited to attend the meeting were F. P. Nagler of Canada, H. von Magnus of Denmark, P. Lépine of France, R. Haas of Germany, Karl Evang of Norway, J. H. S. Gear of South Africa, S. Gard of Sweden, W. L. M. Perry and E. T. C. Spooner of England, and A. D. Langmuir, J. R. Paul, and A. B. Sabin of the United States.

■ A symposium on the "Contribution of systematics to evolutionary studies" was held at the Missouri Botanical Garden, 4–5 Nov. This was the second annual meeting of botanists and zoologists, principally of the Midwest, to be held at the garden for the purpose of encouraging an exchange of ideas on systematic problems fundamental to biology. Sixty-two staff members and 59 graduate students from 31 institutions and 15 states were in attendance.

Karl P. Schmidt of the Chicago Natural History Museum and Reed C. Rollins of the Gray Herbarium, Harvard University, guided the discussions. A few short papers were presented on morphological variation, geographical distribution, phylogenetic trees, and the nature and origin of taxonomic categories. Each paper served as a stimulus to extended discussion.

The symposium raised many questions for which there were no ready answers. It also provided concrete information on clines, taxonomic methods, and geographical step-by-step replacement of animal and plant species. The symposium was generously supported by a grant from the National Science Foundation, which made it possible for many, particularly graduate students, to attend.

■ The Society of Nuclear Medicine is soliciting papers for the 1956 meeting, which will take place at the Hotel Utah, Salt Lake City, on 21–23 June. Titles and outlines of proposed papers should be sent *by 1 Jan.* to Dr. Simeon Cantril, Tumour Institute, Swedish Hospital, Seattle, Wash.

Forthcoming Events

January

17–20. **American Pomological Soc., Rochester, N.Y. (R. B. Tukey, Horticulture Dept., Purdue Univ., Lafayette, Ind.)**

18–20. Soc. of Plastics Engineers, 12th annual, Cleveland, Ohio. (Public Relations Dept., E. I. DuPont de Nemours, Wilmington, Del.)

20–27. **Pan American Cong. of Gastro-Enterology, 5th, Havana, Cuba. (N. M. Stapler, 1267 J. E. Uriburu, Buenos Aires, Argentina.)**

23–26. **American Soc. of Heating and Air-Conditioning Engineers, Cincinnati, Ohio. (A. V. Hutchinson, ASHAE, 62 Worth St., New York 13.)**

23–27. **Inst. of Aeronautical Sciences, New York, N.Y. (S. P. Johnston, IAS, 2 E. 64 St., New York 21.)**

26–27. **Western Spectroscopy Assoc. 3rd annual, Berkeley, Calif. (J. W. Otvos, Shell Development Co., Emeryville, Calif.)**

27–28. Conf. on Protein Metabolism, 12th annual, New Brunswick, N.J. (W. H. Cole, Rutgers Univ., New Brunswick.)

27–28. Western Soc. for Clinical Research, 9th annual, Carmel-by-the-Sea, Calif. (A. J. Seaman, Univ. of Oregon Medical School, Portland 1.)

30–1. **International Conf. on Fatigue in Aircraft Structures, New York, N.Y. (A. M. Freudenthal, 716 Engineering, Columbia Univ., New York 27.)**

30–3. **American Inst. of Electrical Engineers, New York, N.Y. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)**

31–3. **American Soc. of Sugar Beet Technologists, 9th biennial conf., San Francisco, Calif. (Western Beet Sugar Producers, Inc., 461 Market St., San Francisco 5.)**

31–4. **American Physical Soc., New York, N.Y. (K. K. Darrow, Columbia Univ., New York 27.)**

February

1. National Advisory Committee on Local Health Depts., 8th annual, New York, N.Y. (National Health Council, 1790 Broadway, New York 19.)

1–2. **Armour Research Foundation Mid-**

west Welding Conf., Chicago, Ill. (H. Schwartzbart, Armour Research Foundation, Illinois Inst. of Technology, Chicago.)

1–3. Case Studies in Operations Research, Cleveland, Ohio. (Operations Research Group, Dept. of Engineering Administration, Case Inst. of Technology, 10900 Euclid Ave., Cleveland 6.)

2–3. National Symposium on Microwave Techniques, Philadelphia, Pa. (S. M. King, Inst. of Radio Engineers, 1 E. 79 St., New York 21.)

5–8. National Citizens' Planning Conf., Washington, D.C. (Miss H. James, 901 Union Trust Bldg., Washington 5.)

9–10. Soc. of American Military Engineers, annual, Chicago, Ill. (D. A. Sullivan, 72 W. Adams St., Chicago 90.)

16–17. National Conf. on Transistor Circuits, 3rd, Philadelphia, Pa. (J. D. Chapline, Remington Rand, Inc., 2300 W. Allegheny Ave., Philadelphia 29.)

19–23. American Inst. of Mining and Metallurgical Engineers, New York, N.Y. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18.)

19–23. Soc. of Economic Geologists, New York, N.Y. (O. N. Rove, Union Carbide and Carbon Corp., New York 17.)

20–22. American Educational Research Assoc., annual, Atlantic City, N.J. (F. W. Hubbard, AERA, 1201 16 St., NW, Washington 6.)

23–25. National Soc. of College Teachers of Education, Chicago, Ill. (C. A. Eggertsen, School of Education, Univ. of Michigan, Ann Arbor.)

24–25. American Physical Soc. Houston, Tex. (K. K. Darrow, APS, Columbia Univ., New York 27.)

26–29. American Inst. of Chemical Engineers, Los Angeles, Calif. (F. J. Van Antwerpen, AIChE, 25 W. 45 St., New York 36.)

28–29. Scintillation Counter Symposium, 5th, Washington, D.C. (G. A. Morton, RCA Laboratories, Princeton, N.J.)

March

12–16. National Assoc. of Corrosion Engineers, 12th annual, New York, N.Y. (Secretary, NACE, Southern Standard Bldg., Houston 2, Tex.)

14–17. National Science Teachers Assoc., Washington, D.C. (R. H. Carleton, NSTA, 1201 16 St., NW, Washington 6.)

15–16. Food Physics Symposium, 1st international, San Antonio, Tex. (C. W. Smith, Southwest Research Inst., San Antonio.)

15–17. American Orthopsychiatric Assoc., 33rd annual, New York, N.Y. (M. F. Langer, AOA, 1790 Broadway, New York 19.)

15–17. American Physical Soc., Pittsburgh, Pa. (K. K. Darrow, APS, Columbia Univ., New York 27.)

15–17. Kappa Delta Pi, annual, Stillwater, Okla. (E. I. F. Williams, 238 E. Perry St., Tiffin, Ohio.)

16–18. International Assoc. for Dental Research, St. Louis, Mo. (D. Y. Burrill, 129 E. Broadway, Louisville 2, Ky.)

18–24. American Soc. of Photogrammetry, annual, joint meeting with American Cong. on Surveying and Mapping, Washington, D.C. (ACSM–ASP, Box 470, Washington 4.)

19–22. American Acad. of General Practice Scientific Assembly, 8th annual, Washington, D.C. (AAGP, Broadway at 34th, Kansas City 11, Mo.)

19–22. Inst. of Radio Engineers National Convention, New York. (E. K. Gammett, IRE, 1 E. 79 St., New York 21.)

19–23. American Soc. of Tool Engineers, Chicago, Ill. (H. C. Miller, Armour Research Foundation, 35 W. 33 St., Chicago 16.)

21–22. National Health Forum, New York, N.Y. (T. G. Klumpp, National Health Council, 1790 Broadway, New York 19.)

21–23. American Power Conf., 18th annual, Chicago, Ill.. (R. A. Budenholzer, Illinois Inst. of Technology, Chicago 16.)

21–24. American Astronomical Soc., Columbus, Ohio. (J. A. Hynek, McMillin Observatory, Ohio State Univ., Columbus 10.)

23–24. Eastern Psychological Assoc., Atlantic City, N.J. (G. G. Lane, Univ. of Delaware, Newark.)

24–25. American Psychosomatic Soc., 13th annual, Boston, Mass. (T. Lidz, APS, 551 Madison Ave., New York 22.)

(See 16 Dec. issue for comprehensive list)

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